Engineering Library

OCT 28 1935

The Engineer

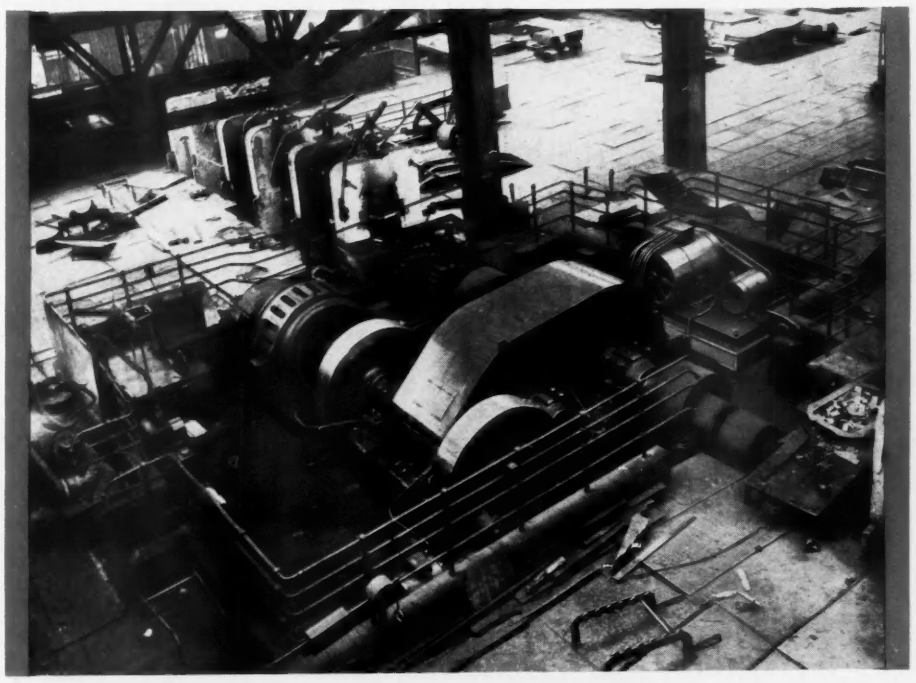
ESTABLISHED 1856. REGISTERED AS A NEWSPAPER.

VOL. CLX.—No. 4162] 28, ESSEX ST., LONDON, W.C. 2. [OCTOBER 18, 1935

THE HEYLAND EXCITER

FOR POWER FACTOR CORRECTION

REDUCES YOUR POWER BILL



HEYLAND EXCITER APPLIED TO A 1000 H.P. ROLLING MILL

THE MOST FLEXIBLE, AUTOMATIC AND LEAST EXPENSIVE METHOD OF CORRECTING POWER FACTOR

18,000 H.P. ALREADY FITTED

THE HEYLAND EXCITER CAN BE APPLIED TO ANY EXISTING SLIP RING MOTOR OVER 50 B.H.P.

Send for full particulars

Laurence·Scott & Electromotors Ltd

NORWICH *and* MANCHESTER

Change of Address

OWING to the increase of our business we have built **NEW SHOWROOMS** for our **MACHINERY DEPARTMENT** at **WOOD LANE, SHEPHERD'S BUSH, LONDON, W. 12** (adjacent to Wood Lane Tube Station, Central London Railway).

From this address our **SECONDHAND MACHINERY** business in London and Southern England will in future be conducted.

Will customers who have been in the habit of writing on **MACHINERY** business to 600, Commercial Road, London, E. 14, or to 62, Glengall Road, S.E. 15, kindly communicate with us at Wood Lane, Shepherd's Bush, W. 12, in future.

Our other addresses—including that of our Head Office at 600, Commercial Road, London, E. 14—remain unchanged ; and the sign of the firm will continue to be

GEORGE COHEN 600

GEORGE COHEN SONS & CO. LTD.

HEAD OFFICE : 600 COMMERCIAL ROAD E.14

WOOD LANE . SHEPHERDS BUSH

L O N D O N . W . 12

Telephone: SHEPHERDS BUSH 2070 (6 LINES) . Telegrams: COBORN, LONDON

And at CANNING TOWN, PARK ROYAL, LEEDS, BIRMINGHAM, NEWCASTLE, SHEFFIELD etc.

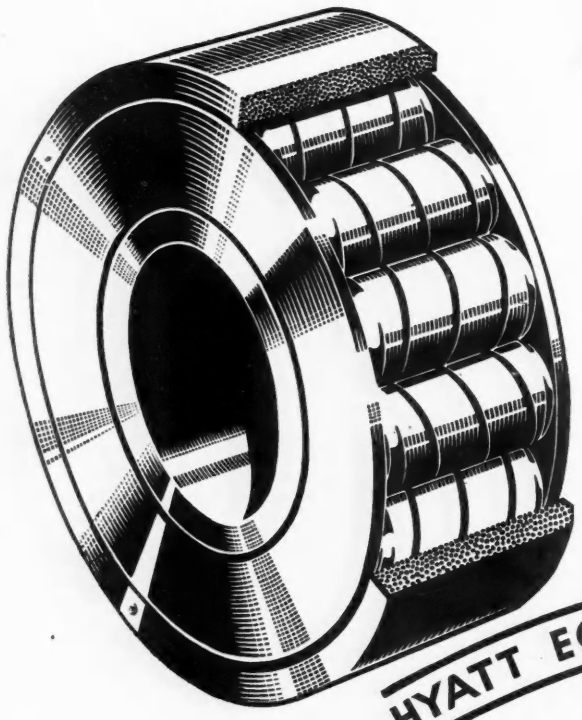
Established 1834

Soanes B/287

HYATT

ROLLER BEARINGS

Applied to



WORKS TRUCKS

Most industries use trucks for transport from one shop to another. Some are man-handled, others hauled by power. In either case free running expedites handling and reduces operating costs and maintenance.

By fitting Hyatt Roller Bearings to truck or trolley wheels or axles, maximum freedom of movement is ensured and, when necessary, heavy loads can be easily man-handled. Hyatt bearings are more easily fitted, require less attention and will stand more abuse in the shape of overload, shock and neglect, than any other type of anti-friction bearing.

Hyatt Roller Bearings are adopted as "Standard" by many Truck manufacturers. It is a simple matter to fit Hyatt to most existing trucks and axles. The improvement and savings would surprise you. Why not investigate ?

HYATT EQUIPPED TROUBLE FREE

Delco-Remy & Hyatt Ltd. 111, Grosvenor Road, London, S.W.1

T.G.S.

A Seven-Day Journal

The Institute of Transport.

The new President of the Institute of Transport is Sir Cyril W. Hurcomb, the Permanent Secretary of the Ministry of Transport, and he delivered his presidential address on Monday evening, October 14th. The title was "Progress in the Co-ordination of Transport in Great Britain." The record, said the President, might be said to have opened with the inaugural address of Sir Eric Geddes (the first President of the Institution and the first Minister of Transport), the Ministry of Transport Act, 1919, and the Railways Act, 1921. The benefits of the latter piece of legislation in the grouping of the companies, the establishment of the Railway Rates Tribunal, and the provision of statutory machinery for the better adjustment of questions affecting labour on the railways, were noted. Then followed a reference to the changes made in the legislation as to highways, from which subject attention passed to road passenger transport, and then to the road and rail controversy, which led to co-ordination of municipal undertakings and other operators, including railway companies, through joint committees. The satisfactory solution of the thorny question of London passenger transport in which the main line companies co-operate was then noted, and attention afterwards paid to the licensing of goods vehicles and the duties of the Area Commissioners. The address concluded with mention of the Transport Advisory Council, which "brings together the leaders of each branch of transport, under an impartial chairman, in an atmosphere which should help to fulfil the hope that the well-being and orderly growth and development of transport as a great public service can be advanced by friendly interchange of views and the responsibility of jointly devising ways and means of overcoming difficulties and resolving differences."

A Proposed School of Refrigeration.

In the course of a speech which was made at the thirty-sixth annual dinner of the British Association of Refrigeration, which took place in London on Friday evening, October 11th, Mr. F. A. Willcox, the President of the Association, advocated the establishment of a school of refrigeration at Cambridge, to which he suggested the name of the late Sir William Hardy, the former Director of the Food Investigation Board, should be attached. Mr. Willcox remarked that research stations had been established for the investigations of scientific problems connected with the industry, but at present there was no means of training men in the knowledge necessary for the full understanding of the results of that research work. A scheme for the training of men was absolutely necessary. In proposing the toast of the Association, Sir Frank Smith, Secretary of the Department of Scientific and Industrial Research, pointed out that Great Britain had not only produced the first refrigerating machine, but it had laid the foundation on which modern refrigeration was based.

Fire Prevention in Cargo Ships.

In view of a recent serious fire which occurred in the engine-room of a ship propelled by heavy oil engines, the Board of Trade has issued to shipowners, shipbuilders, and masters a notice regarding the prevention of fire in cargo ships using oil fuel. In the vessel in question, the notice states, the main engine fuel oil settling tanks were fitted on an oil-tight flat, which was situated over the exhaust pipes. The overflow pipes of the settling tanks discharged into a sump in the flat and the drain pipe from the sump made insufficient provision for conveying a sustained overflow of oil fuel to a safe position. Consequently, when the main engine fuel settling tank overflowed whilst being filled, the escaping oil eventually overflowed from the flat on to the heated main engine exhaust pipes and became ignited. The Board of Trade considers it essential, in the interests of safety, that owners of cargo ships using oil fuel should comply with the same requirements as are laid down in its Instructions as to the Survey of Passenger Steamships, which provide that there should be no possibility of the overflow from oil fuel tanks running into or near any place in which it might be ignited.

A British Foundry School.

In a Journal note of July 5th we announced the formation of a British Foundry School at Birmingham. That school has been constituted under a governing body consisting of representatives of the leading scientific and technical institutions, research associations, and subscribing firms. The school provides a course of one year's duration for men of practical experience in the industry, with the object of equipping them for posts as foundry engineers, metallurgists, and managers. The school opened for its first session on Tuesday, October 15th, when eleven students, nominated by leading firms having their own iron, steel, and non-ferrous foundries, started their course. In most cases the nominating firms have arranged to provide the fees and also maintenance for their students. There is still room for other students, and in some cases students unattached to a particular foundry may be helped by their local education authority. As recorded in our July note, the annual cost of the school, less the receipts from the students' fees, will be about £2000. Subject to the industry raising the sum of £500 per annum, the Board of Education has undertaken to furnish the remainder as a grant. So far, the group of institutions has provided £195 towards the first year's working and the sum of £208 has already been received from industrial firms and persons interested in the scheme. An appeal is made for the remaining £97 still required to complete the £500 to be raised by the industry. It is pointed out that there is still time for prospective candidates to enter for the first year's course. Candidates must have had practical experience in the industry, and must have reached a suitable stage of preliminary education, so as to ensure their being able to profit by the instruction. Further information may be obtained from the secretary of the school, the Principal, Birmingham Central Technical College, or from the hon. treasurer, Mr. J. G. Pearce, 21, St. Paul's-square, Birmingham, 3.

The Engineers' Club, Manchester.

The annual dinner of the Engineers' Club, Albert-square, Manchester, which was held in the Club rooms on Monday last, celebrated the twenty-first anniversary of the birth of an institution which is unique in the United Kingdom, and, we believe, in the British Empire. The chair was filled by the President, Mr. L. E. Mather, son of Sir William Mather, the President in 1913, the year of foundation. The speeches were few, and were all characterised by a lightness of touch proper to the occasion. Mr. H. W. Archer, Editor of *Manchester Evening News*, opened with an address, sparkling with wit, on "The Engineering Industry." Amongst his many effective sallies, he remarked that he had always regarded an engineers' club as a cross between a spanner and a niblick. The response was made by Mr. Loughnan Pendred, who challenged the common idea that mechanisation created unemployment. He pointed out that in the five years 1924–1930, mechanisation, as represented by power consumption, in all factory industries showed an increase of 24 per cent., whilst the reduction in the number of operatives was only 4 per cent.; but in the same period the number of administrative workers increased by 53,000, more than compensating for the drop in the number of operatives. The toast of the evening, that of "The Engineers' Club," was entrusted to Sir Andrew Duncan, and the response was, of course, made by the President. He spoke with some seriousness about the financial position of the Club, and urged the members to endeavour to increase the membership. Sir Felix Pole then proposed the special toast of "Original Members," which was acknowledged by thirty-five members standing up amid loud applause. The only other toast was "Our Guests," proposed by Alderman William Walker. Mr. H. E. Clucas, President of the Chamber of Commerce, responded. Several of the speakers referred with great regret to the absence, owing to ill-health, of Mr. Harry Richardson, who has been the Honorary Secretary continuously since 1918, and whose great services to the Club are generally acknowledged.

Launch of H.M.S. Penelope.

On Tuesday, October 15th, the new British cruiser H.M.S. "Penelope," was launched from the yard of Harland and Wolff, Ltd., at Belfast. The cruiser is the first warship to be built in Belfast since the end of the war, and her keel was laid eighteen months ago by the Duke of Gloucester. She is the first of the three cruisers of the 1933 construction programme, and is of the "Arethusa" class, with a standard displacement of 5200 tons. She is 500ft. long and 51ft. in beam, and she will be propelled by turbine machinery designed to develop about 64,000 s.h.p. and to give a speed of 32·25 knots. The main armament consists of six 6in. guns, and she will carry a seaplane which can be launched from a catapult. The machinery and guns will be installed at Belfast. Speaking at the luncheon which followed the launch, Mr. F. E. Rebbeck, the chairman of the company, said that the launch of the new cruiser meant that the Harland and Wolff yard was now definitely recognised as one of the regular warship-building yards of the country. It was the largest shipbuilding establishment in the world, with foundations and equipment second to none, and it was obvious that there would be no requirements of the Admiralty in the future that the yard could not meet, up to the largest capital ship likely to be contemplated.

Noise of Mechanically-Propelled Vehicles.

The Committee set up by the Minister of Transport last August to consider and report upon the principal causes of noise in the operation of mechanically propelled vehicles has now submitted an interim report. Tests with new engines were carried out by the National Physical Laboratory, and included trials on stationary vehicles and tests at steady and accelerated speeds on the level and at full throttle when climbing on hills. The tests led to the following broad conclusions:—The average present-day "ordinary" motor car under normal conditions of use is not unduly noisy. Certain types of sports cars are too noisy. Except at moderate steady speeds many motor cycles are too noisy, as a result, doubtlessly, of the high power in relation to the size of the machine. Certain commercial vehicles are somewhat noisy, but improvements could be effected by attention to engine and gear noises. The Committee's recommendations, which are with one exception confined to new vehicles, are that on and after August 1st, 1936, no vehicle should be sold for use in this country unless it can pass the following tests:—In the normal running test, when the vehicle is driven with full throttle at 30 m.p.h., using the gear preferred by the driver, the loudness measured at a point 18ft. to one side of the vehicle shall not exceed 90 phons. In the running engine test, when the vehicle is stationary with the engine running at the speed which would give maximum power output, the loudness 18ft. behind the exhaust pipe shall not exceed 95 phons. The "phon" measurement has as its zero the threshold of audibility, and at a value of 130 phons the threshold of feeling of pain. The value 90 to 95 phons mentioned in the tests corresponds to the noise in the interior of a tube train with the windows open. It is suggested that in the case of motor cycles and commercial vehicles, the noise levels shall be relaxed to the extent of 5 phons for two years, in order to give manufacturers time to improve their products, without disturbing manufacturing programmes. It is further recommended that the practice of racing engines of stationary vehicles should be prohibited.

Brake Squeak.

The Institution of Automobile Engineers has recently published the report of its Research and Standardisation Committee on "Brake Squeak." The experiences of manufacturers and operators have been collated, and the results show that although much time and attention has been given to the subject, no infallible cure has been effected, and it is admitted in the report that the fundamental causes of squeak are not clearly understood. Among other factors the atmospheric conditions have an effect on this phenomenon, humid atmosphere being conducive to squeak. In general, it is recognised that squeak is a mechanical fault arising from vibration of some component of the brake mechanism, usually the brake shoe. The brake drum, owing to its properties, tends to amplify the vibrations. With some designs distortion of the brake drum induces squeak, although the heavier designs of drum produced of late have tended to reduce the volume of sound produced. It would appear that the composition of the brake lining does not cause squeak, although linings with a high coefficient of friction are stated in the report generally to augment the sound. The experiences of manufacturers tend to show that a delicate balance exists between the occurrence of squeak and pressure distribution. Many palliatives have been tried, but the report states that none has proved permanent, or even universally applicable. Each case has to be treated separately. The opinion of manufacturers is stated to be that cast iron drums and lower friction coefficient linings are beneficial generally. Of the manufacturers who contributed data, fully 40 per cent. stated that they were not troubled by squeaking brakes.

Petrol from Coal.

The new coal hydrogenation plant at the Billingham works of Imperial Chemical Industries, Ltd., Stockton-on-Tees, was formally opened by Mr. Ramsay MacDonald, Lord President of the Council, on Tuesday afternoon, October 15th. Mr. MacDonald was accompanied by Sir Harry McGowan, the chairman of the company, Dr. Bergius, the eminent German fuel scientist, and a large gathering of representatives of science and industry. The new works are situated on a site, 40 acres in extent, and form part of the related chemical industries carried out at the I.C.I. Billingham works. The output of the new plant may be judged from the fact that it already produces 4 out of every 100 gallons of petrol consumed in this country. Speaking at a luncheon which was held before the opening ceremony in the Middlesbrough Town Hall, Mr. MacDonald referred to the addition to the employment in the mining and engineering industries which the plant had provided, and was still providing. The defence aspect of the work, he said, would also appeal to the country. At the opening of the plant, Sir Harry McGowan stated that its completion brought to a practical commencement an enterprise which had engaged the attention of Imperial Chemical Industries for many years. It was a triumph of chemical research. He expressed his pleasure at the presence of Dr. Bergius, whom, he said, they honoured as the pioneer who opened up a new and enormous potential source of supply of motor spirit and fuel oil. Dr. Bergius's name would go down to posterity with those of the famous chemists who by their genius had enriched the world. The close collaboration of the oil companies had freed Imperial Chemical Industries of the burden of distribution. Shell-Mex and B.P., Ltd., and the Anglo-American Oil Company were responsible for the distribution of the petrol produced at that plant, and he acknowledged the broad-minded way in which the oil companies had welcomed the newcomer.

Dynamometers for Agricultural Research.

By J. S. WILSON, M.A., B.Sc., A. Inst. P.*

No. III.

(*Concluded from page 368, October 11th.*)

Notes on Damping in Dynamometers.

Of the two main types of dynamometer considered, the spring type has far too little damping and therefore produces a record composed of a very close series of zig-zags. To evaluate this the observer has to draw an estimated line to represent the pull and use this line in his measurements of the chart—a somewhat unsatisfactory and uncertain method.

The high sensitivity to impulses which is an inherent property of the spring is therefore rendered of little value, since either the vibration set up by the primary or pull impulses or the undamped impulses themselves cause fluctuations in the record of such amplitude and frequency that they mask the record itself. In some instruments an attempt is made to secure a measure of damping by means of an oil dashpot.

The hydraulic cylinder pattern of instrument, on the other hand, may have the disadvantage that it is overdamped, but, to judge from the typical records from the Institute instrument shown in Fig. 4 (*ante*), this is unlikely. Further, a wide range of damping is available in this type of instrument by choosing a working fluid of suitable viscosity, by altering the bore and length of the connecting pipes employed, or by the use of a throttling valve between the hydraulic link and the indicating device. Experiments with pipes having a bore of $\frac{1}{8}$in. and $\frac{1}{4}$in. showed that there was no appreciable difference in damping between the two, consequently, $\frac{1}{4}$in. pipe is generally employed as this is much more flexible than that having the larger bore. It is possible that the greater volume of oil in the larger pipe has an increased damping effect due to its compressibility which masks any reduction of damping due to pipe friction. The recorder described above is used with engine flushing oil as the working fluid. This functions satisfactorily, and only on test runs of considerable duration during the hottest weather is it necessary to add a little engine oil to it to decrease leakage. For demonstration purposes, however, where maximum damping is desirable to allow for ease of reading the indicating pointer, a service gear oil proves admirable.

Returning to a consideration of the effect of damping on the accuracy of the records of pull, which are made by the hydraulic instrument, it will be noted that any normal record consists of a very large number of maxima and minima, and that the displacement rarely remains constant for any appreciable time. The effect of damping is to curtail the maxima and minima, *i.e.*, to decrease the fluctuations from the mean value of the displacement. Thus, since the maxima are decreased and the minima increased, the error introduced into the mean displacement must be of a high order of small quantities. It will be shown later that a large part of the damping is caused by friction in the hydraulic link and that this friction is proportional to the pressure. Thus part of the damping will be greater at the maxima than at the minima, while the remainder due to fluid friction in the pipes will depend on the amplitude of the variations from the mean value. These variations must, on the balance, be equally above and below the mean value, and thus it appears that this part of the damping will have no effect on the mean value of the displacement.

Certainly the errors due to damping will not be more serious than the uncertainty introduced into the records by the insufficiently damped spring-type instrument, and probably owing to the greater ease with which the former's record can be measured, the overall accuracy is much greater. Experiments designed to compare directly records of the same pull made simultaneously with dynamometers of elastic and hydraulic types in the draw-bar, are contemplated.

It must not be assumed, however, that friction in the hydraulic cylinder can be neglected, for in the process of calibration of the instrument it is far more serious than in the field testing. For some time it had been the custom, in the absence of a suitable testing machine, to calibrate the dynamometer in two parts: (1) the displacement of the indicating plunger against pressure; (2) the pull on the ends of the hydraulic link against pressure, by means of a standard pressure gauge tester. In the calibration of the link it was hung from a 5-ton balance, which was suspended by a screwed eye-bolt from the top member of a rectangular frame. The lower end of the link was fastened to the bottom member of the frame and thus, by tightening a nut on the eye-bolt against the top of the frame any desired force could be placed on the ends of the link and weighed by means of the balance. A pipe line connected the link with the gauge tester and it was possible to apply a pressure to the link and weigh the corresponding "pull" or to find the pull necessary to maintain a definite pressure in the tester.

One method of calibration then consisted in pumping up the link to a definite oil pressure, as shown by the "floating" of the tester beam and weighing, on the 5-ton balance, the corresponding "pull" of the link. A straight line calibration resulted for the lower pressures, but as the load increased towards the working maximum a marked departure from linearity was noted and considered to be due to distortion of the link cylinder. Further investigation, however, showed this to be unlikely and it was finally found that this departure from linearity was brought about by a reversion of friction effects in the link. At the higher pressures, since no particular care was taken to prevent leakage of oil from the system, the pull on the link was driving out the oil and the plunger was moving so as to reduce the volume of oil in the link. At the lower pressures, however, the pump was taking control and the volume of oil in the link was tending to increase. Thus the calibration included points in which the friction in the link was operating to resist and to assist the pull.

Fuller experiments in which it was arranged to control the directions of the motion of the plunger in the link so that it moved in one direction throughout the calibration resulted in two linear calibrations which diverged from zero—representing the effect of friction assisting and opposing the pull on the link. The mean line between these two gave a value for the ratio pull/pressure and this was found to agree accurately with the area of the link plunger as measured. This line corresponded to the true calibration and consequently the true calibration is now determined by simple calculation from plunger area and oil pressure and related to the displacement of the spring loaded plunger.

A further interesting point was noted in an attempt

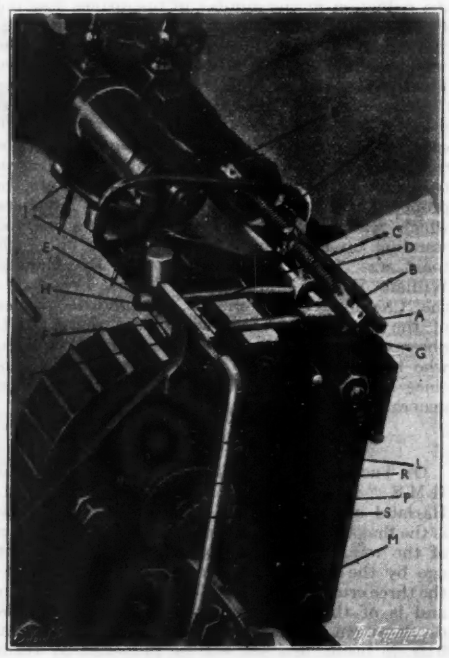


Fig. 5—Detail of Dynamometer

to reduce the friction in the link for work at low loads. The cup leather was removed and in consequence the leakage past the plunger was greatly increased. At the same time, however, the friction had been reduced to a very small amount, but the leakage rate was so high that the instrument was useless for practical work. A new plunger was therefore made and lapped to fit the cylinder and fell freely under its own weight. It had no washer. This plunger reduced the leakage to a value comparable with that obtained with the original plunger and cup leather and at the same time the friction was increased to a value approaching that at the start of the experiment. It seems, therefore, that the diminution of friction (or damping) of the plunger is incompatible with the conservation of a low leakage instrument.

Further experiments to show the effect of oil rings on leakage and friction are in progress.

Integrating Apparatus.

The continual variation in the draw-bar pull makes it necessary that the dynamometer readings during a test run shall be averaged or integrated. Even the early dynamometers, such as that of Morin, incorporated an integrating device, usually of the disc type. A large disc rotates at a rate proportional to the land speed of the implement under test and a small wheel rolls on the disc. The indicating mechanism of the dynamometer causes the wheel to move parallel to itself along a radius of the disc. When there is no draw-bar pull the wheel remains at the centre of the disc and does not rotate, but as soon as a pull is applied to the dynamometer the wheel moves out from the centre and rotates at a speed proportional to the product of pull and land speed, *i.e.*, to horse-power.

This type of integrator is successfully used for railway dynamometry, but the difficult conditions occurring in field work make the friction drive between disc and wheel unsatisfactory.

An ingenious alternative is due to Watson, and was applied to his dynamometer. Four small spring-loaded plunger pumps were mounted together around the axis of rotation of a disc, against which the stems of the plungers pressed. The disc was rotated at a speed proportional to the land speed, and at the same time inclined to its axis of rotation by an amount proportional to the draw-bar pull. Thus the throw of the pumps was proportional to pull and the number of throws per minute proportional to the land speed. The amount of oil pumped per second was, therefore, a measure of the power. The pumped oil drove a hydraulic motor and the speed of this indicated the horse-power. While this is no doubt efficient, the high degree of complication entailed makes it undesirable.

For research work on draught and power consumption it is usually of more value to know separately the values of pull and land speed (*e.g.*, it is generally necessary to test a tractor at definite draw-bar loads). The horse-power when required can then be obtained quickly from the relation

$$\text{h.p.} = \frac{\text{P (lb.)} \times v \text{ (m.p.h.)}}{375}$$

An integrator has therefore been devised which gives an average value of the draw-bar pull over a test (comprising one revolution of the recorder drum). The form of this integrator was largely determined by the lay-out of the Institute's dynamometer recorder, but the principle may well have other applications, where mean displacements are required. The device selects, at regular time intervals, displacements of the indicating plunger, *i.e.*, ordinates of the dynamometer record, adds these up, and shows on dials the mean value of these displacements. As the integrator is used with different sizes of hydraulic link, it was better to have the integrator reading as a displacement of the plunger in inches rather than to mark the dials in pounds pull, since this would have limited its use to one size of link. It has been found that 20 ordinates are sufficient to give an accurate measure of the mean displacement, and comparison of the integrator value for the displacement with the value obtained by several measurements of the corresponding record showed that the integrator reading was inside the range of values obtained from the record.

The parts of the device will be better understood from Fig. 5. An extension A on the plunger carries two posts B between which a bar C is carried by the springs D. The end of this bar is a hardened steel cylinder E, which slides on the bed F, and reproduces there the motion of the plunger. The bed F is on an arm pivoted at G and rests on the recorder drum. The latter carries twenty brass "steps" approximately $\frac{1}{4}$in. high, and all ground accurately to the same height above the drum surface. Thus F is raised a definite amount twenty times each revolution of the drum, and lifts the cylinder E the same amount. A cam H cut accurately to the calculated form is pivoted at K, and is vertically above F, so that E slides to and fro on F beneath the cam, and is just touching the cam at its lowest point.

The form of the cam is such that the displacement at the end of its lever arm L, each time a step passes under F, is proportional to the displacement of E, *i.e.*, to the displacement of the plunger from its zero position.

The movement of the lower end of L is measured by a pawl and ratchet mechanism, and recorded on the dials M.

The importance of the springs D should be noticed. Since the plunger displacement is liable to rapid fluctuation, even in the short time required for a step to pass beneath F and operate the cam, the bar E would, if coupled rigidly to the plunger, be likely to move to and fro beneath the cam while F was lifted by the "step." This would mean that parts of several displacements would be recorded, and the resulting integrator reading would be useless. With the spring coupling, however, the bar E is locked between F and the cam as soon as a step strikes F, and remains locked until the particular displacement at the instant of locking has been noted by the mechanism. The springs are not strong enough to move E after F has lifted it into contact with the cam, however much the plunger may fluctuate.

The integrator is quickly calibrated by displacing E by definite amounts, rotating the drum and noting the corresponding integrator readings. It was found that the relation between plunger displacement and integrator reading was practically linear.

The author wishes to thank the Director of the Institute for Research in Agricultural Engineering, Dr. H. J. Denham, for permission to publish this article.

* Institute for Research in Agricultural Engineering, Oxford University.

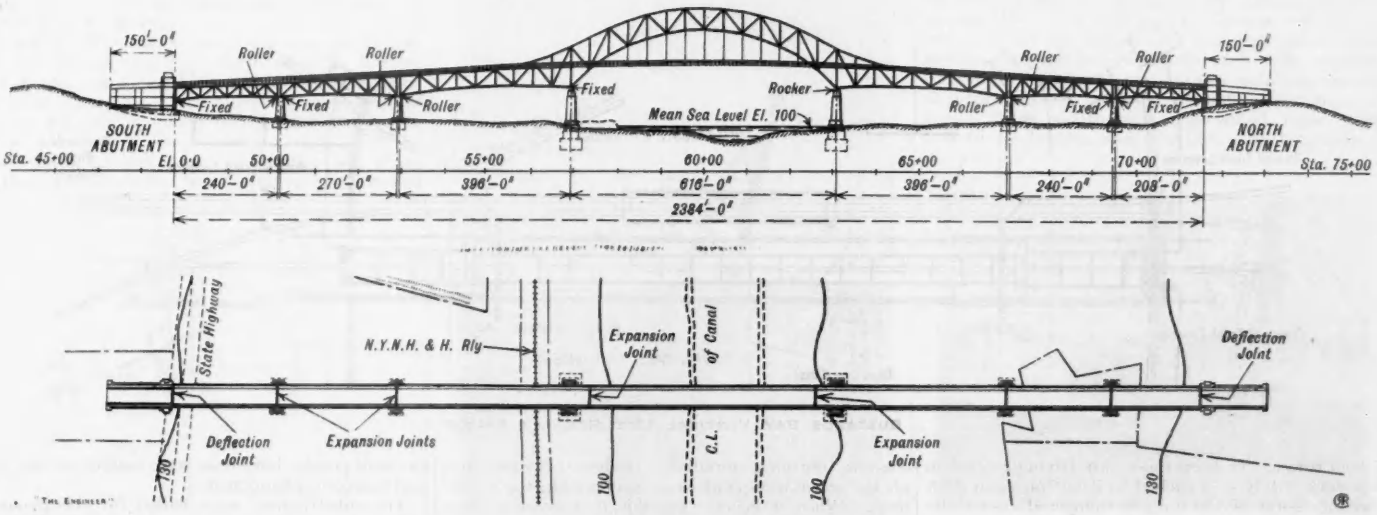
The Cape Cod Canal.

No. II.

(Concluded from page 381, October 11th.)

ALL three of the new bridges are interesting, not only because of what they will do in the way of speeding up both land and water travel, but also because of the difficulties that were successfully disposed of in excavating for their pier foundations. Train movements across the railway bridge will probably not exceed fifty daily even in the summer season, but the highway bridges provide the means of relieving an acute problem. Over each of the two old highway bridges as many as a thousand cars sometimes crossed hourly. The bridges constituted bottlenecks, which caused the backing up of traffic at times for 2 to 4 miles at each approach, the congestion reaching its peak whenever the bridges were opened to allow vessels to pass. Apart from being much more commodious than the old structures, the new bridges afford clearances that permit any vessels likely to use the canal the fullest freedom at all times.

The new highway bridges are about 3 miles apart, the new Bourne Bridge being 3235ft. east of the old structure that it supplants and the new Sagamore Bridge 2500ft. west of the old bridge of the same name. Both bridges are identical in size and design so far as concerns their channel and connecting side spans, but the Bourne Bridge, because of the conformation of the valley crossed by it, has two additional side spans at each end. The steel work of the



BOURNE ROAD BRIDGE OVER CAPE COD CANAL

Bourne Bridge has therefore a total length of 2384ft., while that of the Sagamore Bridge measures 1408ft. The bridges are of the continuous truss type. The channel span is 616ft. long and consists of a steel arch, 270ft. high, from which the bridge floor, for the greater part, is suspended by means of pre-stressed cables. The floor carries a roadway 40ft. wide, providing for four lanes of traffic, and at one side there is a footway 6ft. wide. The floor structure is made up of I beams upon which is laid a concrete slab 7in. thick and finished with a bituminous wearing surface 2in. thick. The side spans immediately adjoining the channel span are 396ft. long. The concrete approach abutments for both bridges are alike in form and have comparatively thin reinforced concrete walls. The roadway over each abutment is carried on a reinforced concrete T-beam deck.

The channel span of each highway bridge rests upon two piers, each of which has a massive monolithic base structure surmounted above water by two rectangular columns carrying the bearings for the channel and side spans. Each pier base has a maximum section of 50ft. by 108ft. and was designed to measure 25ft. vertically. Unexpected geological conditions compelled a modification in these footings. Each superposed rectangular column is 32ft. by 32ft. in cross section at the bottom, and tapers to the top. The columns are hollow throughout their upper 71ft. The piers are faced with cut granite at the water line. The Government specification required the pier bases to be set on a compacted gravel formation at a depth of approximately 48ft. below mean sea level.

The contractor for the substructures of the two highway bridges, the P. J. Carlin Construction Company, New York City, had a choice of procedure, but elected to use open cofferdams in getting down to the prescribed depths for the piers. It was assumed that not more than 10 per cent. of the steel sheet piling would be prevented from reaching the specified depth by interposed boulders, but many more boulders were struck than were expected, and those obstacles were often large, the biggest being 90 cubic yards. At the south pier of the Bourne Bridge the boulders were angular instead of rounded, as is commonly the case, and those angular boulders could not be removed by ten or more successive piles were thus arrested, and the resulting gaps in the side of the cofferdam made it virtually impossible to control the inflow of water by means of the sump pumps. In the end, the difficulty was mastered by the employment of well points that were sunk immediately adjoining the inner wall of the cofferdam. In this manner the water was lowered sufficiently to permit the breaking up and removal of the boulders. Dredging was carried out to a depth of 40ft. below mean sea level, but blow-outs were almost sure to occur if the bottom of the excavation were unwatered below a depth of 44ft. At this juncture the responsible officers of the U.S. Corps of Engineers modified the plans to the extent of permitting the substitution of wooden piles as the immediate support of the pier footings, instead of requiring the footings to rest directly on gravel at the greater depth prescribed in the specification.

In accordance with this change, oak piles, ranging in length from 30ft. to 35ft., were driven from 22ft. to 27ft. into the formation under the entire area of the main piers, a total of 560 piles being so driven with steam hammers. The hammers were directed underwater by extension guideways formed of steel angles. Divers, equipped with pneumatic saws attached to lines, cut off the ends of the piles at a uniform level. The close spacing of the piles compacted the ground and improved its supporting capacity. A footing of concrete, 21ft. in thickness, was then poured upon the piles, and sealed the bottom of the cofferdam. The bottom of the south pier of the Sagamore Bridge was thus placed 44ft. below mean sea level, 8ft. higher than originally planned. Because of this change, the steel sheet piling was not withdrawn, as required by the specification, but was burned off at depths of from 20ft. to 30ft. below water as a defence against scouring, should the channel in the future be dug to a depth of 40ft., as is contemplated. Generally speaking, the cofferdam work was similar at the other piers for the highway bridges, except that the angular boulders at the south pier of the Bourne Bridge, which were closely placed, caused many of the steel piles to split, bend, or twist when driven. At that pier, after excavation had been carried manually to a depth of 37ft., buckets, jets, and divers continued the work 7ft. deeper, where the gravel formation without the use of wooden piles was found firm enough for the emplacement of the pier footing. A single set of well points, together with the sump pumps, sufficed to keep under control the water entering the cofferdam.

The vertical lift railway bridge at the village of Buzzards Bay is the most interesting of the three new canal crossings. Furthermore, the construction of the supporting piers proved more difficult than the corresponding work on the highway bridges. Operations in connection with the new railway bridge were hampered by the nearness of the old railway bridge, and continued care had to be exercised to avoid endangering the old structure by the work on the new one. The channel piers of the new railway bridge are set 550ft. apart from centre to centre, and rising from each is a lift tower that reaches a maximum height of 275ft. The lift span, 544ft. between end bearings, will have a total vertical travel of 130ft. When the span is down the railway tracks will be 14ft. above mean sea level, and when the span is raised it will afford a clearance of 135ft. for shipping at high water. Ordinarily, the span will be kept up, and will be lowered only for the crossing of trains, the number of which is far fewer than that of the vessels moving through the canal. The bridge will carry one track. Unlike the two highway bridges, which are so situated that elevated approaches are practicable, the railway bridge had to be of a type that would avoid any pronounced change of gradient, and therefore a vertical lift bridge offered the best solution of the problem. The bridge was designed by Parsons, Klapp, Brinckerhoff and Douglas, consulting engineers of New York City, who were aided in certain aspects of the work by McKim, Mead and White, architects, also of New York.

The floor and trusses of the lift span and the floors of the spans at the rear of the towers are of silicon steel. The two front columns of each tower are of silicon steel, while the remainder of the tower structure is of carbon steel. The lift span will be moved by means of eighty wire ropes, each 2¼in. in diameter, passing over eight sheaves at the tops of the towers and connected to counterweights. The sheaves will be 15ft. in pitch diameter, and will be geared to electrical motors capable of raising or lowering the span through 130ft. in 2 minutes. Should the public supply of electricity fail, petrol engine generator sets at the bridge will furnish the necessary power, and will take about 6 minutes to raise or to lower the span. Theoretically, since the span is counterbalanced there should be needed only sufficient power to overcome friction, but an excess of power is provided to deal with an added load of snow and ice. Further, the span will be kept permanently heavier than the counterweights, so that it will rest firmly on the piers, even when not locked. The counterweights are steel boxes nearly filled with concrete. In each there are four wells in which more concrete or blocks of cast iron can be placed for the close regulation of the balance. To neutralise the unbalancing effect of the main counterweight ropes when they pass from one side of the sheaves to the other, there is to be in each tower a compensating auxiliary counterweight. The prescribed balance will be such that the span in the down position will be about 20,000 lb. heavier than the counterweights, and it will also be somewhat heavier than the counterweights when in the open position. The movable span will weigh approximately 4,150,000 lb. The wire ropes connecting the span and the counterweights will have a weight of 120,000 lb., and the bridge, when operating, will represent a total of 8,400,000 lb. of material in motion. When rising or descending the lift span will be restrained from swaying by guide rollers arranged to engage flanges on the tower columns. The counterweights are to be held in a similar manner by guide shoes of nickel-chromium steel, engaging angles extending the full height of the tower columns. At

each corner of the lift span there will be an air buffer to prevent shock while the span is being seated on the piers or when it is being brought against the stops in the full open position.

Locks will hold the span when open or closed, and there will be, in addition, rail locks that will come into action in the lowered position. To meet the possible contingency of having to replace a number of counterweight ropes at one time or to replace any part of a sheave, there will be hanger links at the top of each tower from which the counterweights may be suspended when the lift span is jacked up at the piers. The rope sheaves are to be equipped with self-aligning roller bearings of the straight roller type. The electric plant will consist of one motor of 150 h.p. in each tower. To keep these two driving motors in step, each will have attached to it on the same shaft a second motor of 150 h.p., so connected electrically that they will come into action only if the primary motors fail to work in unison.

A single operator will control the opening or closing of the bridge from a station in a house just above the floor level of the north shore span. In addition to controlling the main driving motors, he will operate the brakes, span locks, and navigation signals. The brakes, actuated electrically, are designed to come into action through the agency of heavy springs when power is cut off from them either accidentally or otherwise. The bridge will carry coloured and flashing lights to serve as signals for aircraft and shipping, and these lights will be switched on or off automatically night and morning through the medium of photo-electric cells. Indicators in the operating room will show the position of the span during its vertical movement, and whether or not it is level. Limit switches will automatically prevent the span from approaching either end of its travel too rapidly and the switches will stop it should it get out of level by more than a foot.

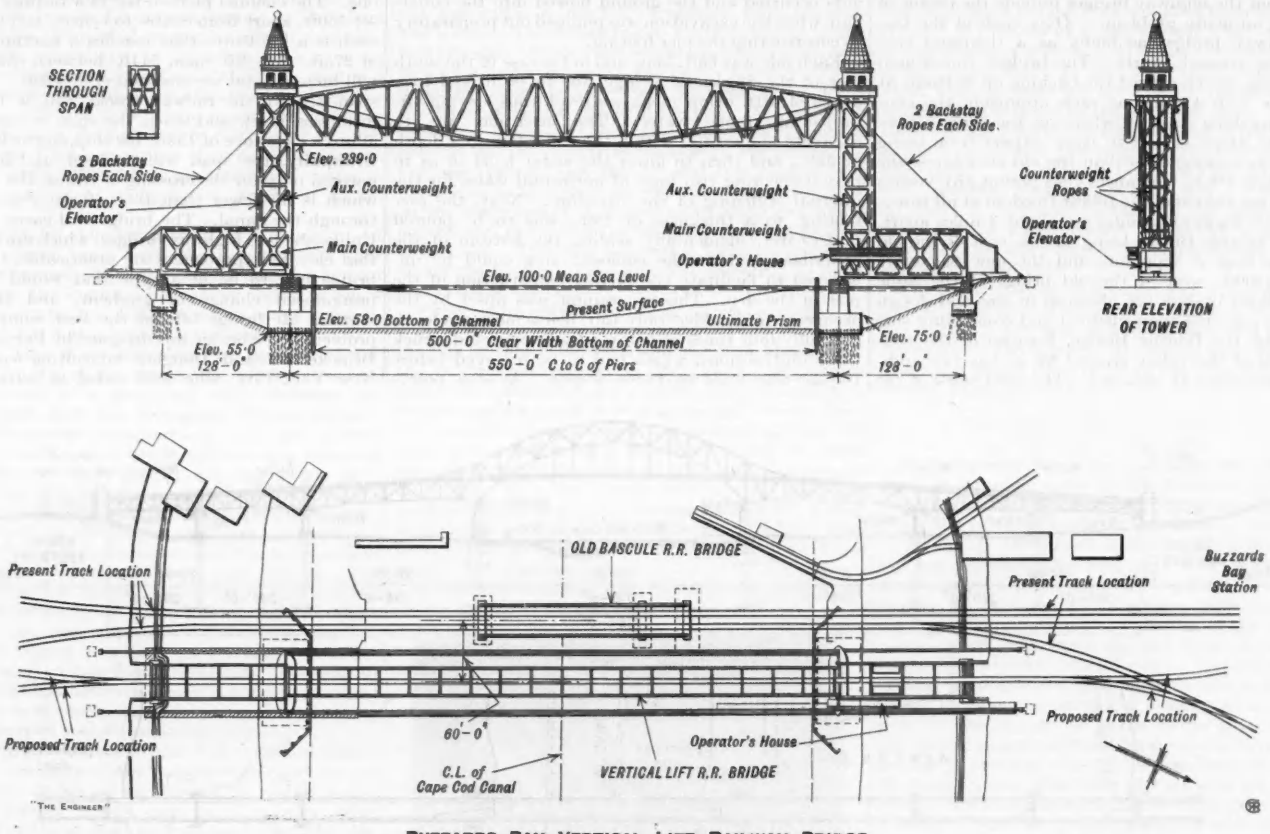
The substructure work on the railway bridge was executed by the Blakeslee-Rollins Corporation of Boston. The consulting engineers proposed the use of pneumatic caissons for erecting the main piers, but the contractor asked to be permitted to employ open cofferdams for the foundation work. Inasmuch as construction was started nearly at the same time on all three bridges across the canal, the Blakeslee-Rollins Corporation could not profit by the unforeseen difficulties encountered by those engaged on similar operations for the highway structures. Water at all the sites for the railway bridge piers, exceptionally large and numerous boulders, and the proximity of the old railway bridge made the work extremely difficult and at times hazardous.

At the south main pier work proceeded without serious trouble until a depth of 25ft. was reached, where boulders were encountered, and similar obstructions were met at the north pier at a depth of 20ft. These boulders interfered with the driving of the steel piles and had to be removed. The boulders averaged a little less than 2 cubic yards in size, while the largest of them was of 74 cubic yards. In all, 327 boulders had to be removed. The irregular penetration of the piling caused by the boulders resulted at times in blow-outs or an inrush beneath the cofferdam walls when an effort was made to pump out the enclosure with the object of getting at the boulders to break them up preparatory to removing them. In the end, an extensive use of well-points enabled the contractor to keep the water under control and to hold it at such a level that the boulders could be disposed of and the cofferdam structure completed.

At the site of the north main pier the contractor employed five rings of well-points, each point extending to a depth of 16ft. below its header. The 6in. header pipes were placed successively at four different levels, and approximately 350 well-points were employed in unwatering this especially troublesome cofferdam. The uppermost ring of well-points lay between the main cofferdam and a comparatively shallow outlying auxiliary timber cofferdam but all the other well-point rings were within the cofferdam. When it became possible to excavate below the second highest ring of well-points, those points were projected through openings in the sheeting and were used to keep down the level of the water in the soil lying outside the cofferdam.

Despite these and other difficulties the excavations for the north and south main piers were carried down to a depth of 45ft. below mean sea level. At that stage the requirements were changed. The excavation was stopped at that level instead of going 17ft. deeper, as originally required, and 324 oak piles were driven in each excavation to a depth of about 32ft. into the underlying formation. These piles were cut off 4ft. above the bottom of each hole and concrete was poured over them to form the bases of the piers. Those bases measured in plan 44ft. by 88ft. The two inshore or abutment piers were similarly supported by oak piles—112 piles being driven under each. It was necessary to keep a considerable number of well-points in service until after the main pier bases were poured up to the final level. To facilitate their subsequent withdrawal, the well-points were previously enveloped by 15ft. lengths of 6in. pipe, which were left embedded in the concrete. This plan made it possible to retrieve the majority of the well-points, but some were caught in the gravel and had to be abandoned.

The substructure work called for the placing of 9600 cubic yards of concrete and of 302,000 lb. of reinforcing steel. The concrete was consolidated, either by vibrating it or by vibrating the forms. The contract for the substructure was awarded in December, 1933, and was completed early in January of the present year. The steel for the superstructure has been supplied by the Phœnix Bridge Company. The bridge will contain a total of 4,000,000 lb. of carbon steel and 4,600,000 lb. of silicon steel.



BUZZARDS BAY VERTICAL LIFT RAILWAY BRIDGE

Salving the Ex-German Battleship "Konig Albert."

WE have from time to time during recent years* described and illustrated the varied and interesting salvage operations connected with the raising of certain ships of the sunken German battle fleet, which was scuttled at its anchorage at Scapa Flow on June 21st, 1919. Up to September, 1933, that work was, with conspicuous success, carried out by Cox and Danks, Ltd., of London and Sheffield. In the autumn of 1933, however, the salvage undertaking, together with the plant owned by Cox and Danks, Ltd., and the salvage department at Lyness, was taken over by Metal Industries, Ltd., of Glasgow and Rosyth, and new salvage vessels and equipment were added. The new salvage ships included the "Bertha," purchased from the Southern Railway Company, which now has air compressing equipment with a total capacity of 2500 cubic feet per minute, also electric generating plant installed. The "Bertha" was converted by the Grangemouth Dockyard Company, Ltd., and went into service early in February, 1934. Afterwards the Norwegian lighthouse tender "Anna V" was purchased and equipped for salvage and towage work at Grangemouth, a total capacity of 1200 cubic feet per minute of air compressors being installed, together with electric auxiliaries, generating plant, &c. She has been renamed "Metinda." The first work to be undertaken by the new firm was the raising in 1934 of the 28,000-ton battleship "Bayern," which lay upturned in 20 fathoms of water. That ship is now being broken up at the firm's yard at Rosyth. Attention was next turned to two ships of the German "Dreadnought" class, the "Konig Albert" and the "Kaiserin," which have a displacement of about 25,000 tons and an overall length of 568ft. They were lying in deeper water, but on July 31st, 1935, the "Konig Albert" was, after eight months' strenuous work, successfully raised. We are indebted to Mr. T. McKenzie, the chief salvage officer of Metal Industries, Ltd., who, it may be recalled, was also principal assistant to Mr. E. F. Cox, for the following account and the illustrations of the salving of this, the latest ship to be raised.

The "Konig Albert."

The "Konig Albert" was laid down at the Schichau Yard, Danzig, in July, 1910, and was completed in August, 1913. She had a waterline length of 564ft. 6in. and beam of 95ft. 6in., with a mean draught of 27ft. 3in. Her propelling machinery consisted of a three-screw arrangement of turbines, taking steam

* See The Engineer, Destroyers, September 9th, 1925; "Hindenburg," October 1st, 1926; "Moltke," June 1st, 1928; "Seydlitz," February 22nd, 1929.

from fifteen Schulz-Thornycroft water-tube boilers, and both coal and oil fuel were carried.

In October last year four of the firm's best divers were detailed to make a thorough survey of the wreck, and their reports indicated that the vessel was lying bottom up, with a port list of approximately 9 deg. Her bow was in 23 fathoms and her stern in about 21 fathoms. The sea bed was reported to be very soft, and all the turrets and the superstructure were reported to be completly buried in the mud. The whole position was reviewed, and it was decided that while the "Konig Albert" was a difficult salvage

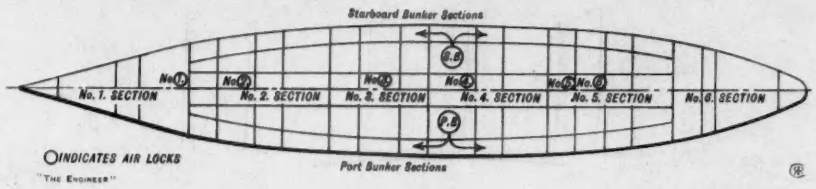


FIG. 1—THE SUBDIVISION OF THE "KONIG ALBERT"

proposition, the task was by no means a hopeless one, and that the work should immediately proceed. It was at once seen that the use of compressed air was obviously the only method. The first operation consisted, therefore, of locating all bottom valves, main inlets, submerged torpedo tubes, &c., which were sealed up with a special rapid hardening cement.

THE SALVAGE PLAN.

It was decided to divide the ship into six sections transversely and into three sections longitudinally, by making use of her water-tight bulkheads, as shown in Fig. 1 herewith.

Air Locks.—The use of air locks was, of course, necessary, and as the least depth over the bottom of the wreck was about 85ft., air locks, each 100ft. long, were necessary. The general arrangement of a typical air lock is shown on Fig. 2. They were built at the Lyness base, 4 miles away from the wreck. Each air lock, when completed, was slung from the jib of a pontoon (see Fig. 3) and then towed

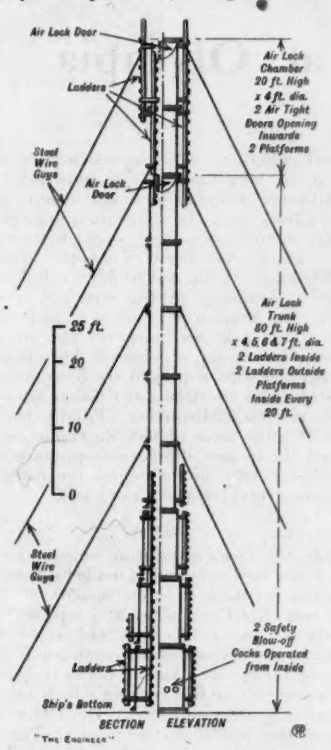

Air Lock Door
Ladders
Air Lock Chamber 20 ft. High x 4 ft. dia. 2 Air Tight Doors Opening Inwards 2 Platforms
Steel Wire Guys
Air Lock Door
Air Lock Trunk 80 ft. High x 4.5, 6 & 7 ft. dia. 2 Ladders Inside 2 Ladders Outside Platforms Inside Every 20 ft.
25 ft.
20
10
0
Steel Wire Guys
2 Safety Blow-off Cocks Operated from Inside
Ladders
Ship's Bottom
SECTION
ELEVATION
"THE ENGINEER"

FIG. 2—TYPICAL AIR LOCK

out to the wreck. The pontoon was securely moored over the wreck in the required position and the air lock was lowered until the bottom flange was almost resting on the hull of the wreck. A view of this operation is shown in Fig. 8 on page 404. Two or more divers then placed the air lock exactly in the required position, and the work of drilling and tapping holes through the hull was begun, using the holes in the lower flange of the air lock as a template. Another diver screwed studs into the holes and secured the air lock to the hull as quickly as possible, while two more divers passed up guys to men on top of the air lock, who secured them and set them tight with stretching screws in the shortest possible time. The whole operation may look simple on paper, but was, in fact, a very difficult piece of work in practice. If the reader will try to visualise a steel cylinder, 100ft. long and weighing over 25 tons, swinging from a 70ft. jib on a pontoon riding on a choppy sea, and moored on temporary anchors, which have had no time to bed in, he may gain some idea of the difficulties which were often experienced before an air lock could be placed in the exact position. The placing of an air lock was an operation which could only be carried out on a reasonably calm day, and calm days during the winter months at Scapa are few and far between. The officer in charge usually heaved a sigh of relief when he saw the air lock in place and eight or ten top guys set taut. The first air lock was fixed on the "Konig Albert" on November 29th, and a few days later it had been thoroughly secured by eighty-two ¾in. diameter bolts and twenty guys.

HULL OPERATIONS.

The water was then expelled from inside the air lock by air pressure, and as soon as the hull of the wreck was clear of water, a manhole was drilled through and an entrance made into the ship. Water was then pressed down to below the tank top level and a manhole cut through the tank top. The work of reclaiming the bulkheads was then begun, and as the water level receded it was carried on until the bulkheads had been sealed air-tight down to the battery deck level.

Positive buoyancy could have been obtained by

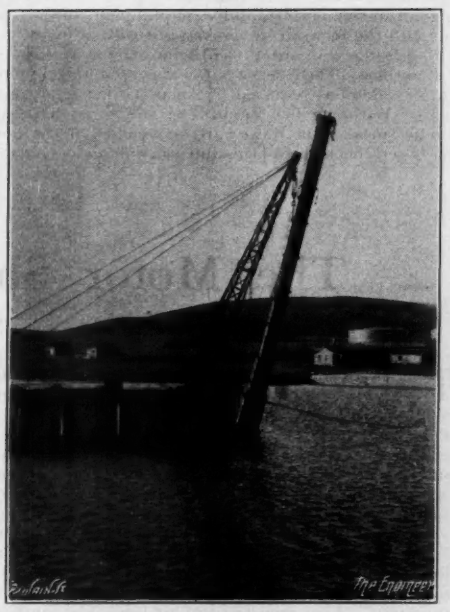


FIG. 3—AIR LOCK AND PONTOON

reclaiming the bulkheads only to the armour deck, but at that level stability could have been a negative quantity when the ship lifted; hence the necessity for reclaiming them to the lower level.

Eight air locks were fixed in position by the end of April, 1935, and work was being carried on inside the ship by about forty men working in relays at pressures ranging from 45 lb. to 55 lb. per square inch.

After the bulkheads had been reclaimed to a certain level, strange as it may seem, one of the chief problems was not to lift the ship, but to prevent her from lifting before she was ready. It was only possible to bring two adjoining sections to the full pressure at any one time, as otherwise the buoyancy would have become positive, and would have caused the ship to lift, with possibly disastrous results to the men inside the wreck, and to the working of the scheme in general.

Work was pushed ahead in one section after another. Immediately a section was completed, it was evacuated, the blow-off cocks were opened, and the air in the section was exhausted to atmospheric pressure. Months of difficult and dangerous work carried out under the most arduous conditions were necessary to reclaim the bulkheads, and many of the men had to work in wading dresses with water almost

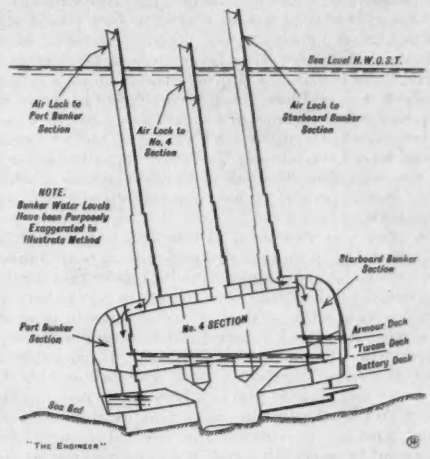


FIG. 5—SECTION OF WRECK, SHOWING LIST

up to their necks for lengthy periods. Much deliberate damage had been done by the German officers and crew before the ships were scuttled, while much greater damage had been caused by the immense rush of water against the various bulkheads as the ship turned over. All such damage had to be made good; doors had to be strong-backed, heavy pipes had to be broken and blanked, and hundreds of

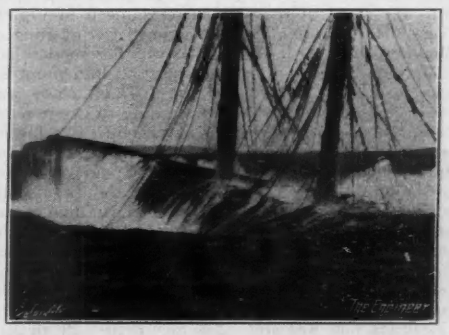


FIG. 6—BOW RAISED 20 FEET ABOVE SURFACE

cables, ventilators, &c., had to be cut and the apertures sealed up, before the bulkheads could be made air-tight. The frequent gales and adverse weather conditions often caused delay, and boating operations between the salvage steamers and the air locks were often difficult and dangerous. Fig. 10 on page 404 shows one of the salvage craft in a rough sea.

On more than one occasion when a sudden gale sprang up the men had to remain on top of the air locks for several hours before they could be got back to the salvage steamers. The cases of compressed air illness were fairly frequent, but re-compression chambers

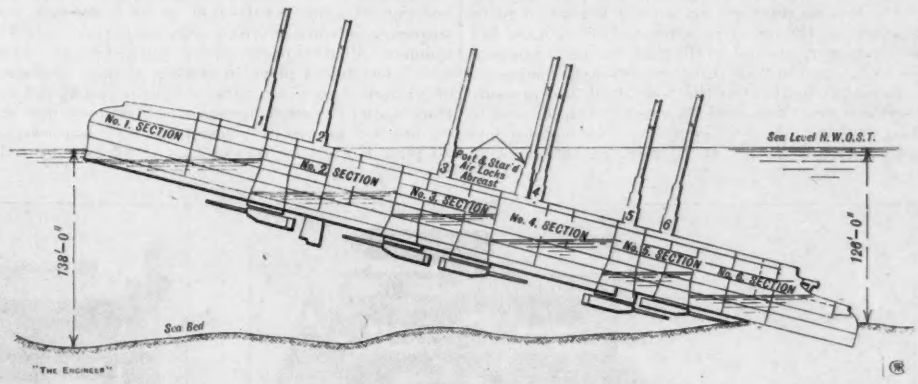


FIG. 4—THE SHIP IN THE BOW-RAISED CONDITION

were fitted both on the salvage steamers and ashore, and immediate treatment was always available.

THE FINAL STAGES.

The work of sealing the bulkheads to a sufficiently low level was completed at the end of the third week in July this year, and the final preparations for the lifting of the ship were then begun. The

tonnage of the wreck was about 25,000, and it was estimated that the net material weight when submerged, including coal and stores, was approximately 22,100 tons, and equal to a displacement of 773,500 cubic feet of salt water. The depth to which the bulkheads had been reclaimed gave a very considerable safety margin over that figure.

The question of correcting the list was the next problem. Past experience in the use of compressed air on salvage work had shown that the amount of righting lever required to correct a list with a ship resting, even lightly on the botton, is almost incalculable. If, however, a lever sufficiently strong to correct the list as the ship left the bottom had been applied, it would have been far in excess of what was required when the upward movement and the consequent expansion of the air took place, and the result would have been a heavy list in the opposite direction. It was therefore decided to strike a medium, which later events proved to be a reasonably accurate and sound judgment.

A glance at the cross section (Fig. 5) shows that with a 9 deg. port list, the pressure in port bunkers requires to be approximately 5 lb. higher than that in starboard bunkers, in order to get an equivalent displacement of water. That 5 lb. difference in pressure, however, displaced a very much larger volume of water when expansion took place. It was decided that the safest method would be to allow the ship to leave the bottom practically without any righting lever and to depend on the extra expansion in the port bunkers to correct the list. Pressures were arranged accordingly and compressing air at full power into the main sections was begun on Friday, July 26th. The scheme was to lift the fore end first, then to correct a list if necessary, and finally lift the stern. A drawing of the ship with the bow raised is shown in the engraving, Fig. 4.

The forward sections were almost at lifting pressures on Saturday, the 27th, when a north-westerly gale sprang up and operations had to be suspended. The new salvage steamer "Metinda" had to slip her moorings and anchor off, to prevent damage, but the "Bertha," which was very heavily moored, was able to hold on and maintain the air pressure in the wreck. A view of the salvage craft pumping air into the stern of the ship is reproduced in Fig. 9, page 404. The gale continued until the evening of Monday, July 29th. When the weather moderated, "Metinda" was put back in position and pumping was resumed. On Tuesday at 10 a.m. there was positive buoyancy forward, according to gauge readings, but still there was no movement. At 1 p.m. when gauge readings indicated that there was approximately 4000 tons positive buoyancy forward of the longitudinal centre of gravity and about 3000 tons negative buoyancy abaft the longitudinal centre of gravity, the bow commenced to break free. Allowing for errors in gauges or in calculations, it was safe to assume that between 3500 to 4000 tons extra buoyancy was required to break the suction and tear the turrets, superstructure, &c., out of the mud. The rise of the bow was quite slow for the first 2ft. or 3ft., but immediately the terrific expansion of air became effective, it simply shot to the surface.

In 30 to 40 seconds the bow was 20ft. above water. Huge columns of air, water, and oil fuel shot skywards, and considerably over a million cubic feet of surplus air was exhausted. For a short period the forward air locks were almost completely obscured by the clouds of spray and columns of water. A typical view of the rising bow and the turmoil caused by the escaping air is shown in Fig. 6.

The port list increased slightly to about 11 deg. as the upward movement of the bow commenced, but as the expansion of the air in the port bunker became effective it came back to 7 deg., and was steady at that figure when things settled down. Every man remained at his post and carried out his duty in the most thorough manner. Twenty-two lines of flexible pipe and six anchor wires had to be slackened or tightened in a matter of seconds, but the orders were obeyed at the first word of command and no hitch occurred. Compressors were connected aft about two hours after the bow lifted, and pressure in sections four, five, and six was built up almost to lifting pressure. Enough excitement for one day had been experienced, and at 10 p.m. operations were suspended until the morning. In the early morning of Wednesday compressors with a capacity of over 3000 cubic feet of free air per minute were connected aft. At 9.55 a.m. the "Stand by!" signal was given, and at a few minutes after 10 a.m. the stern freed itself and rushed to the surface.

The expansion and subsequent escape of excess air, together with the huge displacement of water, caused by the wreck breaking surface, made the salvage vessels roll and sheer. Wires surged tight, but nothing broke. The 7 deg. port list disappeared, and zero was recorded on the indicators about a minute after the ship broke surface. The upward thrust of the stern caused the bow to dip very low, but this movement had been anticipated. The air compressors had been connected forward at the first sign of movement aft, and were pumping compressed air into the forward sections at the rate of over 2000 cubic feet per minute, even before the stern was on the surface. The reserve power was used for pumping into bunkers as required, to keep the list at or near zero. Within a few minutes of the time the stern broke surface, the downward movement of the bow had been checked, and the ship was well under control. At twelve noon the "Konig Albert" had 14ft. freeboard fore and aft.

The enormous amount of work carried out by the divers in deep water became apparent for the first time as the 100ft. air locks and network of guys (see Fig. 11, page 404) stood out against the skyline.

In conclusion it may be added that apart from a few small delays, which were caused by adverse weather conditions, the salving of the "Konig Albert" was carried out almost exactly to the programme planned. After she had been raised, she was, the following day, towed nearly 2 miles to shallower water, and was beached near the shore with her funnels, bridge, and superstructure touching the bottom, as indicated in Fig. 7. At a later date the underwater projections were blasted away, and the ship was towed to the Lyness base, where she is now being prepared for her final voyage to the firm's shipbreaking depôt at Rosyth. The difficult piece of salvage work which we have described was only made possible, Mr. McKenzie informs us, by the loyalty and devotion to duty of the whole of the salvage staff, to whom the unqualified success of the whole operations was in a large measure due.

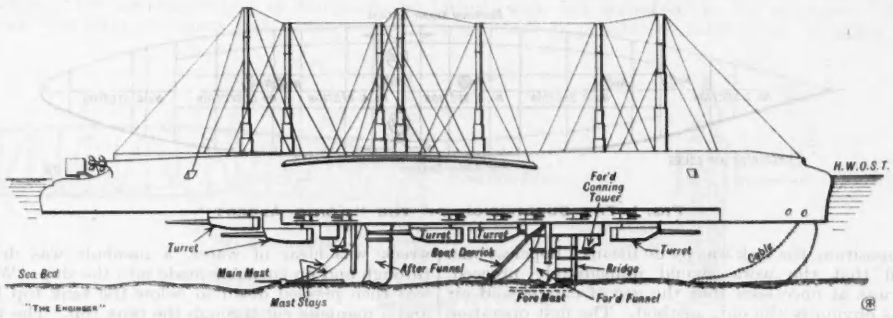


FIG. 7—THE SHIP AS BEACHED AFTER BEING RAISED

The Motor Show at Olympia.

No. I.

THE twenty-ninth International Motor Exhibition held by the Society of Motor Manufacturers and Traders, Ltd., was opened on October 17th. It provides the engineer with a means of judging the progress and trend of design of engines, transmissions, and suspension systems, and indicates the probable lines on which problems connected with these matters are to be solved. This year the transmission question seems to have become more stabilised. Designers are generally contenting themselves with detailed improvements to the various gear-boxes, clutches, and automatic systems, which the last few years have produced. Free wheels seem to have lost some of their popularity, owing perhaps to the increased adoption of simple gear-changing systems which have taken away one of the advantages of the free wheel, while the increased congestion on the roads has accentuated its disadvantage, namely, the lack of an engine brake in emergency. The new taxation relief has been answered by an increase in engine horse-power generally felt over the entire industry. The new engines are quieter, have better acceleration, and increased reliability, owing to the reduction of engine revolutions which has followed the increase of engine bores. This improvement will doubtless have its effect on the colonial market, where our "high revving" engines used often to be looked at with suspicion, in spite of strong colonial patriotism. The Colonies will also appreciate the marked improvement which has taken place in chassis design. Stiffeners of various types are now fitted to nearly all the frames, and the whole question of chassis springs and torque and torsion absorption has been improved at all points. Arising out of this problem comes the widespread adoption of independent front wheel suspension, which by abolishing the front axle has done away with some of the "wracking" strains to which a chassis is subjected. In addition, it guards against the displacement of one front wheel with regard to the other which may occur when the springs are expected to locate them, and which results in what is known as "shimmy" in the steering. The care with which the front wheels are held in position on this year's cars will, we hope, see the end of this dangerous phenomenon, which arose when front wheel brakes, together with improved acceleration, imposed greater strains on the front suspension system than it could bear without distortion. Finally, the general adoption of some form of flexible engine mounting has caused the chassis designer to produce a frame which does not rely on the engine for stiffness, but which forms a rigid framework of itself.

Engines.

Probably the most interesting engine shown this year is the new twelve-cylinder, made by Rolls Royce, Ltd., Coventry. It has a cubic capacity of 7340 c.c., which gives an R.A.C. rating of 50·7 h.p., and consists of two six-cylinder banks mounted at 60 deg. A single cam shaft set above the crankshaft operates all valves by push rods. An automatic tappet adjustment is provided on the rockers which are carried on excentrically mounted pins. The latter on rotation take up the clearance or increase it. The rotation is carried out by the valve push rods, which operate an oil-controlled mechanism, which ensures that the correct setting is maintained at each stroke. Ignition is by battery and two independent coil ignition sets,

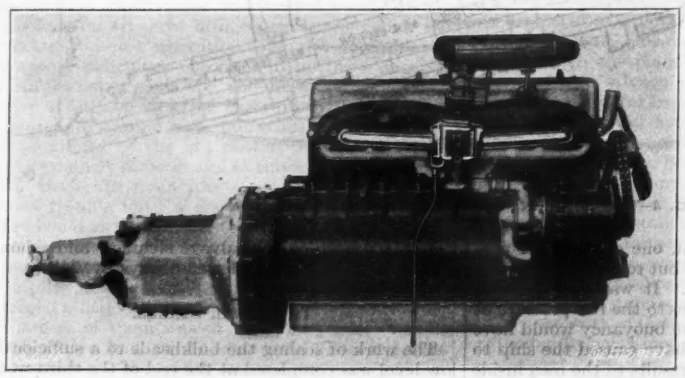


FIG. 1—DIAMLER LIGHT STRAIGHT EIGHT

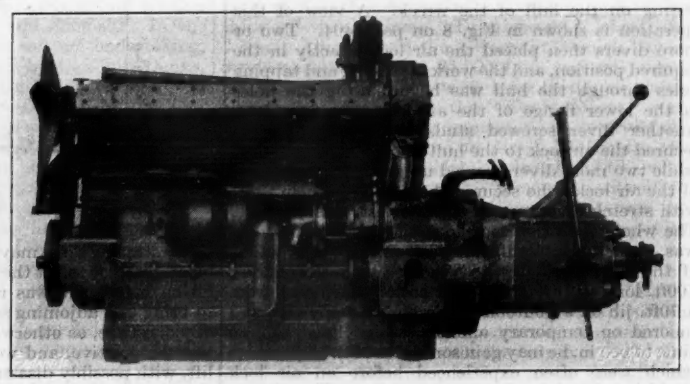


FIG. 2—BUGATTI STRAIGHT EIGHT

giving dual ignition, the advance being fully automatic. The carburation system draws its air from a large silencer running the length of the engine, fitted with two air inlets protected by cleaners. From the thermostatically operated radiator shutters, a system adopted by Rolls Royce some years ago as allowing all the water to be warmed up gradually and preventing it cooling down too quickly.

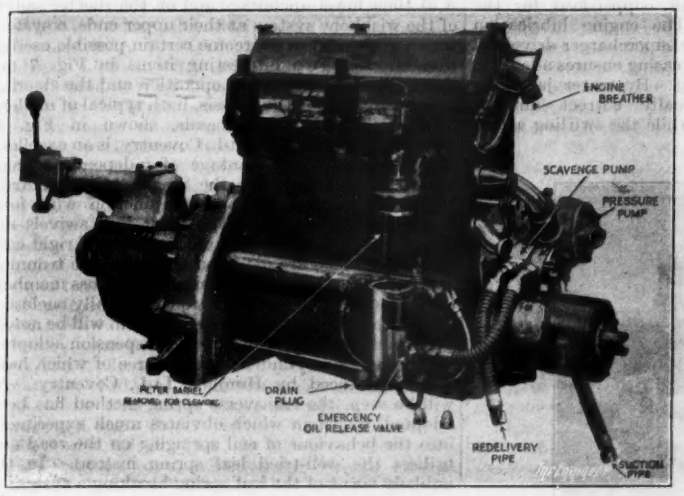


FIG. 3—ASTON MARTIN MARK II ENGINE

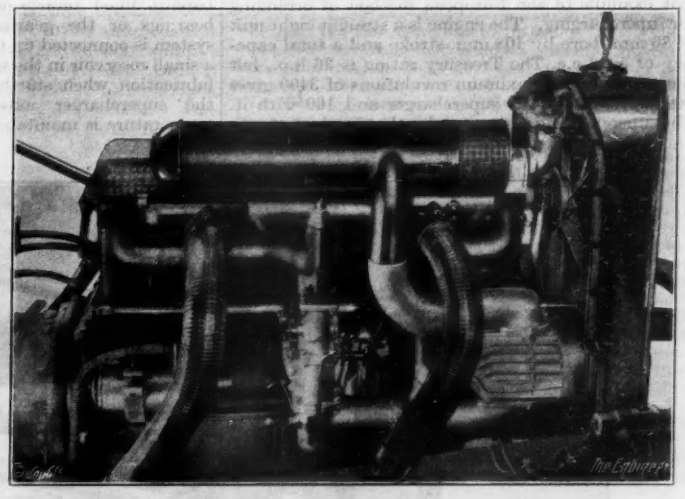


FIG. 4—ARRANGEMENT OF SUPERCHARGER ON MERCEDES-BENZ ENGINE

silencer four carburetters draw their air, and each feeds a set of three cylinders. Lubrication is by forced feed, a cooler connected to the water pump outlet being interposed at the oil pump outlet. Three oil

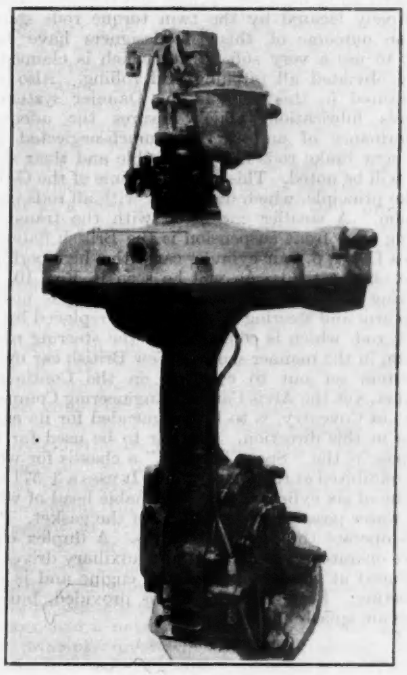


FIG. 5—GRAHAM-PAIGE SUPERCHARGER UNIT

pressures are provided by means of spring-loaded relief valves, which allow 50 lb. per square inch for shaft bearings, 10 lb. per square inch for the overhead valve gear, and 1¾ lb. per square inch for the

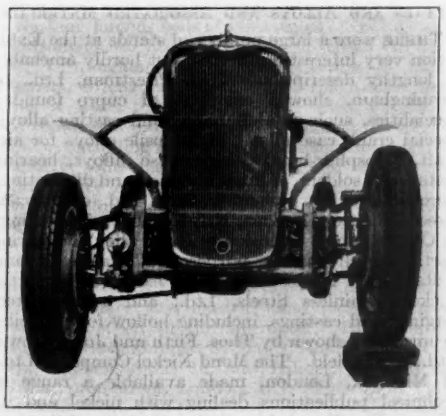


FIG. 6—SINGER FRONT SUSPENSION

timing gear. The two crank case breathers which are in the overhead valve gear are connected to the air silencer. Separate "wet" cylinder liners are fitted in the engine, together with detachable aluminium cylinder heads. Temperature control is by

Another interesting engine is that of the "Light Straight-Eight" car, manufactured by the Daimler Company, Ltd., Coventry. It is illustrated in Fig. 1. Here an integral cylinder head is used, which is claimed to eliminate distortion, improve valve cooling, and save trouble with gaskets. Overhead valves are operated by push rods. The engine is 72 mm. bore by 105 mm. stroke, giving a capacity of 3·421 litres. The carburation system is unusual. A dual down-draught carburetter feeds two separate induction pipes, one supplying the centre four cylinders, the other, the two outer pairs of cylinders. With the Daimler firing order, the arrangement is such that each carburetter is operating under the same conditions as in a four-cylinder engine. To

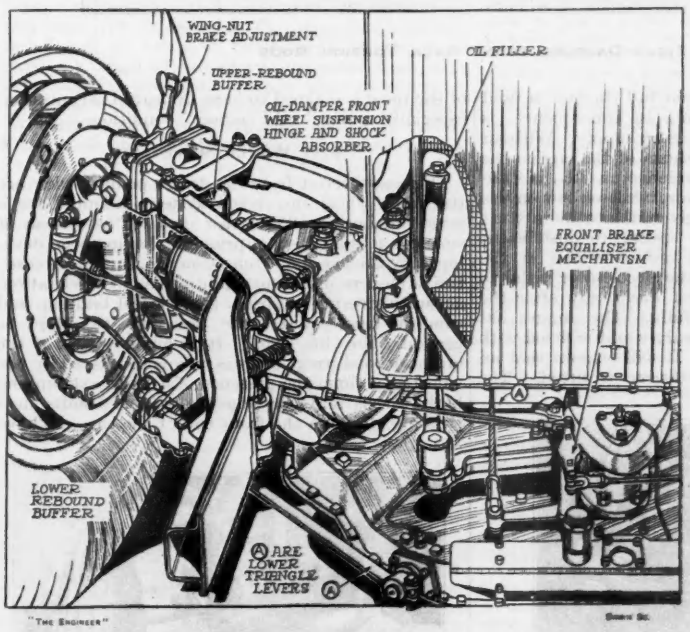


FIG. 7—ROLLS ROYCE FRONT WHEEL SUSPENSION

also increases the richness in proportion to the degree of throttle opening, so that the engine will not stop when the accelerator is pressed after starting up from cold. A notable feature is the large air silencer fitted.

The other engines produced by the Daimler, Lanchester, and B.S.A. works remain substantially as during last year. In Fig. 2 the Bugatti straight eight engine and gear-box unit is shown. This engine is of the high-performance type. It has two cam shafts, each operating one valve per cylinder, driven from the rear of the engine. The auxiliaries are also driven from the rear, which, as can be seen, in no way makes them inaccessible. Another high-performance engine is shown in Fig. 3, the Aston Martin "Mark 2." This engine is unchanged from last year. It is lubricated on the dry sump system, twin oil pumps being used. One pump functions in the normal way, but is fed from a separate oil tank; the other takes oil from the engine sump and delivers it to the oil tank. By this means the oil is kept at a much lower temperature than would be possible in the engine sump, and, in fact, the Aston Martin Company claims that the temperature cannot be raised above 75 deg. Cent. under any conditions of use. The engine itself is an overhead cam shaft model, the drive being by chain from a countershaft which is driven at half engine speed, so that the actual chain speed is low, an important point in an engine doing 5000 r.p.m. The valve system is interesting, in that instead of the usual cotters each valve stem is threaded to take a collar and locking nut. It will be seen that the engine water pump is connected to the upper part of the

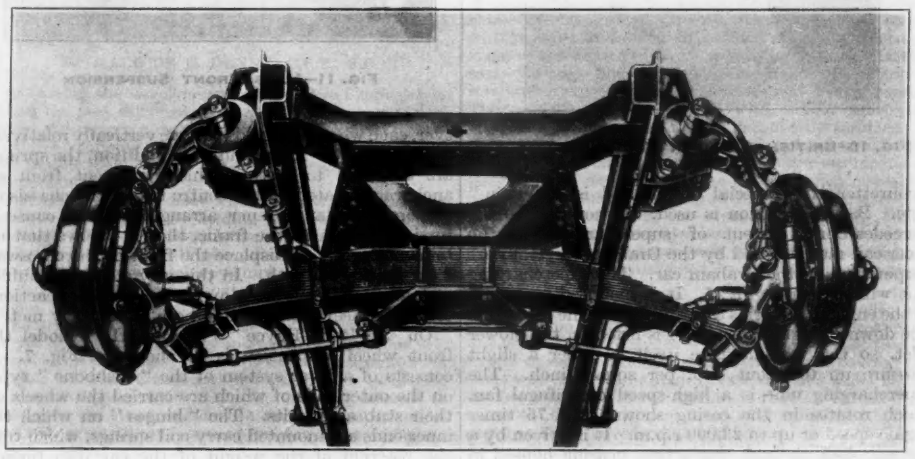


FIG. 8—HUMBER INDEPENDENT FRONT WHEEL SUSPENSION

cylinder block. This arrangement is adopted because the cylinder walls are cooled by thermo-syphon, the pump maintaining a water stream through the cylinder head to keep an even temperature through the engine. Fig. 4 shows the type "500" Mércedes-Benz supercharged engine. It is an excellent example of the European method of arranging for supercharging. The engine is a straight eight unit of 86 mm. bore by 108 mm. stroke and a total capacity of 5018 c.c. The Treasury rating is 36 h.p., but the engine at its maximum revolutions of 3400 gives 100 h.p. without the supercharger and 160 with it. The supercharging system used is that in which the air

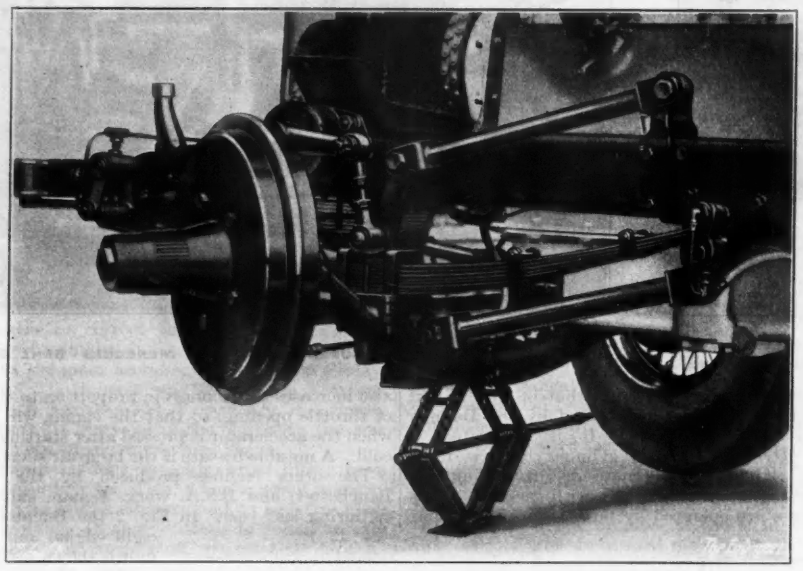


FIG. 9—DAIMLER FRONT AXLE TORSION RODS

pressure is increased only when full throttle is used and when the engine suction, in consequence, is insufficient to provide the necessary supply. Without supercharging on high revolutions of the engine the "wire drawing" of the induction pipe, &c., is sufficient to starve the engine of air, while on low engine revolutions, if full throttle is given, the entire mixture supply may be inadequate owing to insufficient suction. Both these faults are overcome in the Mércèdes-Benz by utilising the accelerator pedal to "clutch-up" the supercharger drive only after the throttle has been opened fully. The engine has push rod-operated overhead valves and is fitted with a detachable cylinder head. It will be seen that an adequate air cleaner and silencer is fitted. The

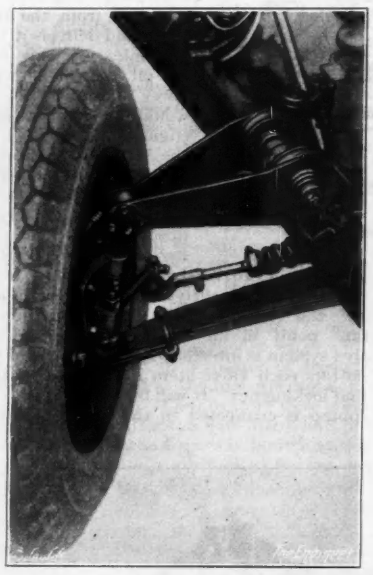


FIG. 10—BRITISH SALMSON FRONT ASSEMBLY

carburetter is of special design and is a "twin" type. Battery ignition is used. In contrast to the Mércèdes-Benz system of supercharging is the American method used by the Graham-Paige Motors Corporation on the Graham car. The supercharging unit will be seen in Fig. 5. It is mounted vertically on the engine and forms a part of the engine assembly. The down-draught carburetter is fitted on the blower inlet, so that the mixture itself is under a slight pressure up to about 4 lb. per square inch. The supercharging unit is a high-speed centrifugal fan, which rotates in the casing shown at 5·75 times engine speed or up to 23,000 r.p.m. It is driven by a vertical shaft through worm type gearing housed in the casing shown. The whole unit is fitted approximately at the centre of the cylinder block, where the induction pipe can best be connected to the rotor unit, the driving shaft be coupled to the distribution gearing *viâ* the water pump, and the water jacketing of the supercharger be coupled to the water pump outlet. The bearings of the whole unit are either babbitt lined bronze or plain copper-lead for the bearings or the gearing. The engine lubrication system is connected up to the supercharger drive and a small reservoir in the worm casing ensures adequate lubrication when starting up. By water jacketing the supercharger automatically correct mixture temperature is maintained, while the swirling action of the rotor is claimed to have improved carburation, especially under "cold engine" conditions.

Front Wheel Suspension.

Of great interest from the design point of view are the front wheel suspension systems adopted for a large number of 1935 motor cars. This system of suspension is not new in principle, having been developed by Lancia about ten years ago, but the necessities of modern motoring conditions as to acceleration, accurate steering at speed, front wheel braking, and comfort have caused the designers to adopt it generally for this year. It is obvious that if the ordinary road irregularity is only encountered by one wheel at a time, the presence of a front axle linking both wheels and carrying the vehicle results in a twisting effect on the front end of the car. If, however, each wheel is hinged to move vertically relatively to its side of the frame and if, in addition, the springs are arranged to restrain this movement from an anchorage located on the centre line of the chassis or in some similar manner arranged not to cause a torsional strain on the frame, then it follows that no tendency exists to displace the front of the car away from its normal path. In this way steering troubles at high speed have been overcome and the reactions of front wheel braking have been adequately met.

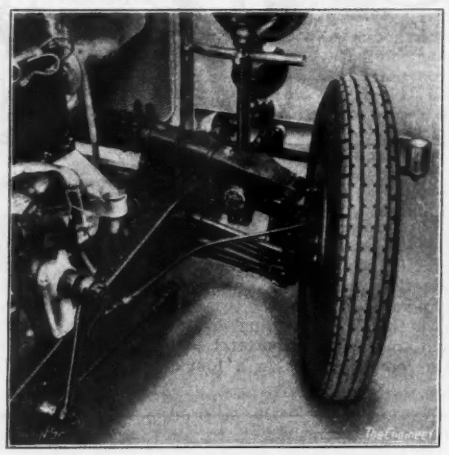


FIG. 11—ALVIS FRONT SUSPENSION

On the Rolls Royce "Phantom III" model the front wheel suspension is as shown in Fig. 7. It consists of a lever system of the "wishbone" type, on the outer ends of which are carried the wheels on their stub axle units. The "hinges" on which the inner ends are mounted carry coil springs, which turn the reaction of the weight of the car into torsion applied to the individual frame members, which are increased in depth to withstand it. The coil springs are encased in an oil bath, together with separate shock absorbers, the oil acting as a damper to oscillations. Rebound buffers are fitted. The wheels do not move in a truly vertical path, as they actually travel on the radius of the lower triangle levers marked A at their lower anchorage and on the shorter radius of the wishbone system at their upper ends, a system which is claimed to overcome certain possible oscillation effects. Two interesting items in Fig. 7 are the method of front brake operation and the steering arm set well inside the chassis, both typical of modern design. The 11 h.p. chassis, shown in Fig. 6, built by Singer and Co., Ltd., Coventry, is an excellent illustration of the advantage of independent front wheel suspension. Here the Singer "Gordon Armstrong" system is used in conjunction with low-frequency coil springs. The front hub swivels are carried on pairs of parallel motion arms of rigid construction, which are mounted on transverse trunnion shafts running inside the tubular front cross members of the frame. The bearings are thus totally enclosed. The method of jointing the steering arm will be noted. Fig. 8 shows the "Evenkeel" suspension adopted for the new six-cylinder models, three of which have been introduced by Humber, Ltd., Coventry. As will be seen, the transverse spring method has been adopted, a system which obviates much experiment into the behaviour of coil springing on the road and utilises the well-tried leaf spring instead. In the unlikely event of the leaf spring breaking a system of anchor rods maintains the front axle in position, as will be seen. The simplicity and robustness of the chassis design is also visible, the frame being built as a box girder throughout. By contrast with the preceding examples, the front suspension of the Daimler light straight eight, which we illustrate in Fig. 9, appears orthodox. It is, nevertheless, an example of the same trend of design, in that all torque is taken away from the springs and the front axle is positively located by the twin torque rods shown. As an outcome of this the designers have been able to use a very soft spring, which is claimed to have obviated all pitching and rolling. Also well illustrated in this view is the Daimler system of chassis lubrication, which ensures the adequate performance of an otherwise much-neglected job. The new brake rods are just visible and their small size will be noted. This is the outcome of the Girling brake principle, which does away with all rods under torsion. A smaller car fitted with the transverse spring type front suspension is the British Salmson. It is a 11·9 h.p. four-cylinder car with a high performance on the road. As will be seen in Fig. 10, the steering is operated without the use of the normal drop arm and steering rod, which are replaced by the track rod, which is connected to the steering mechanism, in the manner shown. Few British car manufacturers set out to compete on the Continental market, yet the Alvis Car and Engineering Company, Ltd., of Coventry, is to be commended for its enterprise in this direction. The car to be used for this purpose is the "Speed Twenty," a chassis for which was exhibited at the Paris Salon. It uses a 3·571 c.c. engine of six cylinders, the detachable head of which has water passages independent of the gasket. Push rods operate the overhead valves. A duplex chain drive operates the cam shaft and auxiliary drives. It is placed at the rear end of the engine and is self-adjusting. Forced lubrication is provided, but the cams are splash lubricated.

(*To be continued.*)

The Shipping, Engineering and Machinery Exhibition at Olympia.

No. VI.

(*Concluded from page 376, October 11th.*)

Metals and Alloys and Associated Materials.

There were a large number of stands at the Exhibition very interesting to visit, but hardly amenable to lengthy description. T. J. Priestman, Ltd., of Birmingham, showed examples of cupro foundry specialities, such as aluminium sand casting alloys, special crank case alloys, high-tensile alloys for aircraft, phosphor-bronze, zinc base alloys, bearing metals and solders. Aluminium sand and die castings were exhibited by Robert W. Coan, Ltd., of Duncan-street, Islington, London, N.1, together with castings in Coanailium, a corrosion-resisting alloy for marine parts and all outdoor purposes. "Stainless" and "Staybrite" rustless steels were exhibited by Firth-Vickers Stainless Steels, Ltd., and various steel forgings and castings, including hollow forged boiler drums, were shown by Thos. Firth and John Brown, Ltd., of Sheffield. The Mond Nickel Company, Ltd., of Millbank, London, made available a range of technical publications dealing with nickel and its alloys. The Sheepbridge Stokes Centrifugal Castings Company, Ltd., of Chesterfield, exhibited typical components in special alloy cast irons. British Pigirons, Ltd., of 2, Victoria-street, London, had examples of "Midhill" and "Glenhill" special pig irons on show. "Gartsherrie" and "Eglinton" brand Scotch pig irons were exhibited by William Baird and Co., Ltd., of Glasgow. Another firm show-

ing pig irons and refined alloy pig irons was Bradley and Foster, Ltd., of Darlaston. This firm has recently begun the manufacture of chilled steel abrasives. Hematite pigs of several foundry qualities were shown by Colvilles, Ltd., of Glasgow. William Cumming and Co., Ltd., of Glasgow, exhibited a wide range of foundry facings. Pressure and gravity die castings in various alloys and general foundry castings were shown by Fry's Diecastings, Ltd., of Merton Abbey, London, S.W.19. "Workington" and "Distington" West Coast hematite pig irons produced by the Workington Iron and Steel Company, and examples of the uses of plates made by the Appleby-Frodingham Steel Company, Ltd., were to be seen on the stand of the United Steel Companies, Ltd., of Sheffield. Samples of foundry, forge and basic and special pig irons, together with iron ores, slags, and ganister, were shown by Stewarts and Lloyds, Ltd., of Glasgow, Birmingham, and London. A number of firms in the foundry trades section showed materials associated with the casting, heating, and melting of metals, among whom were British Foundry Units, Ltd., of Chesterfield; Stirling Foundry Specialties, Ltd., of Bedford; General Refractories, Ltd., of Sheffield; and the Carborundum Company, Ltd., of Manchester. "Hiduminium" high-tensile aluminium alloys as castings, forgings, stampings, tube sheet, bar, &c., were exhibited by High Duty Alloys, Ltd., of Slough. Electrically upset forgings were exhibited by Heatly Electric Forgings, Ltd., of Willow-avenue, Barnes, London, S.W.13. Condenser tubes and various other non-ferrous tubes were exhibited by the Yorkshire Copper Works, Ltd., of Leeds.

Other Exhibitors.

Many other firms had interesting exhibits at Olympia. The Alfa-Laval Company, Ltd., of Great West-road, Brentford, Middlesex, exhibited a variety of centrifuging apparatus, including a new type of oil separator which is hermetically sealed, so that the oil is not affected by contact with the atmosphere during its passage, while the bowl can be put under a pressure above that of the atmosphere if it is desired to work with a volatile liquid. Tilghman's Patent Sand Blast Company, Ltd., of Broadheath, near Manchester, had, besides several air compressors, a new form of fettling plant developed in America. In this machine the castings to be cleaned are subjected to a shower of sand or steel shot, projected centrifugally from a "Wheelabrator." The scheme is said to reduce power consumption, by comparison with a compressed air blast to about one-tenth. The resultant finish which we inspected at the Exhibition was excellent. We had an interesting conversation with the representative of the Multi Curve Cutter Company, Ltd., of Singapore, which has a London office at 152, Fenchurch-street. This cutter was evolved with the primary object of boring out the lignum vitae linings of steamships' stern tubes; but might be used for a variety of other purposes. A pair of curved cutters is fixed in the spindle of a milling machine, and by the adjustment of their angle with respect to the axis of rotation provide an opportunity for machining the stern tube lining to the proper dimensions at very short notice. Alfred Graham and Co., Ltd., of Caxton House, Tothill-street, Westminster, is a name generally associated with loud-speaking telephones, and such-like equipment, and was appropriately represented in that direction, but the firm had a novelty in the form of a fire alarm. The principle involved, which has already been referred to in our "Patents" columns, is the melting of a very thin metallic film, which constitutes an electrical circuit when subjected to an abnormal temperature. The metal film is made up as a narrow strip of fusible alloy attached to the back of a strip of paper. This strip is pasted on the vulnerable parts of the walls of a room to be protected and a circuit established through a relay to give an alarm. J. Parish and Co., of Erith, Kent, had a stand on which there were demonstrated the excellent qualities of the long-famous beds of silica sands of that district. Electromagnets, Ltd., of 2, Church-street, Colmore-row, Birmingham, 3, had a collection of lifting magnets, a magnetic separator of the rotary drum type, a water-tight chute fitted with adjustable and removable inductifier bars, arranged for mechanically controlling the flow of liquid and the magnetic intensity, some magnetic clutches, and chucks, and a laboratory magnet for testing purposes, which is also useful for prospecting. Triple gear chain blocks and other lifting tackle and associated equipment were shown by Felco Hoists, Ltd., of 17, Victoria-street, Westminster, London, S.W.1. Desoutter Brothers, Ltd., of the Hyde, London, N.W.9, exhibited pneumatic and electric hand tools, including a new high-speed air turbine router. Tube-bending machines were exhibited by Major, Robinson and Co., Ltd., of Manchester, 15, and Hilmer, Ltd., of 65, Southampton-street, London, N.1. The Spiral Tube and Components Company, Ltd., exhibited air heaters for warming factories and for use in manufacturing processes. Electric hand tools, including drills, screw-drivers, nut runners, sanders and grinders, were set on view and shown in action by Black and Decker, Ltd., of Slough. Sextants, binnacles, compasses, binoculars, and numerous other devices were shown by Heath and Co., of New Eltham, London, S.E.9, who also showed the "Allbrit" planimeter. "Eclipse" products, including the non-electric magnetic chuck, hack saw blades, and frames, and saw sets, were shown by James Neill and Co. (Sheffield), Ltd. The Consolidated Pneumatic Tool Company, Ltd., of 170, Piccadilly, London, W.1, had on view pneumatic tools for many purposes, including riveters and chippers, tube beading tools, scaling tools, hammers, grinders, drills, and polishers. The Fescol process is by now well known, and examples of Fescolised products were shown by Fescol, Ltd., of 101, Grosvenor-road, London, S.W.1. Microscopes, spectrographs, and numerous other exhibits were to be seen on the stand taken by Carl Zeiss (London), Ltd., of 40, Wells-street, London, W.1. A water circulator and also the collection and removal of mud, oil, and air from a boiler was demonstrated by Arthur Ross, Hotchkiss and Co., Ltd., of 1, Glengall-road, London, S.E.15. Short centres belt driving by means of the "Autoflex" drive was demonstrated by Wearn's Autoflex Drives, Ltd., of 2, Sloane-terrace, London, S.W.1. Opperman, Sons, and Tasker, Ltd., of 50, Wharf-road, London, W.10, exhibited worm gears to transmit from ½ to 25 h.p., single and double-reduction gears, and spur, bevel, spiral and worm wheels for all classes of engineering. Among the exhibits of Thomas Mercer, of St. Albans, were dial micrometer indicators, giving readings to 0·0001in. "Flexo" belt dressings, tinning compounds, and asbestos furnace cement, and "Permac" metal-to-metal jointing material were among the exhibits of Thomas and Bishop, Ltd., of 37, Tabernacle-street, London, E.C.2. A boiler circulator guaranteed by the makers to save 5 per cent. in fuel or increase steaming capacity by 10 per cent. was demonstrated by Owens Boiler Circulator (1930), Ltd., of 57, Victoria-street, London, S.W.1. The products of Tecalemit, Ltd., of Brentford, are well known in almost every branch of engineering, and many examples of the firm's products were to be seen at Olympia. Clocks, time recorders, bell indicators and fire alarm apparatus found a place on the stand taken by Gent and Co., Ltd., of Leicester. Among the specialities of Ross Courtney and Co., Ltd., of Ashbrook-road, London, N.19, exhibited at Olympia were hydraulic jacks, and all kinds of turned and pressed metal parts. A fusion welded water-tube boiler drum, 27ft. long, 3ft. 6in. diameter, with a plate thickness of 1⅛in., was to be seen on the stand of John Thompson (Wolverhampton), Ltd. Driving chains of various kinds, chain clutches and couplings, flexible couplings, and conveyor chains were exhibited by the Renold and Coventry Chain Company, Ltd., of Manchester. Siebe, Gorman and Co., Ltd., of 187, Westminster Bridge-road, London, S.E.1, showed breathing and safety appliances for various circumstances.

Other firms exhibiting were:—Steelway, Ltd., of Wolverhampton, steel flooring, ladders, and hand-railing; James Walker and Co., Ltd., of Woking, packings and jointings, for steam, fluids or gases; Wellworthy, Ltd., of Lymington, piston rings, valve seats, &c.; Beldam Asbestos Company, Ltd., of Hounslow, packings for steam and fluids; Silentbloc, Ltd., of Notting Hill Gate, London, W.11, bearings and anti-vibration mountings; Clensol, Ltd., of 75, Victoria-street, London, S.W.1, treatment of feed water and household water softening; Grant and West, Ltd., 17, South-street, London, E.C.2, jointing compounds, belt treaters, rope preservatives, &c.; Guest, Keen and Nettlefolds, Ltd., of Birmingham, wood and metal screws and screw nails; Richard Crittall and Co., Ltd., Bloomsbury-square, London, W.C.1, fans, magnetic valves, air diffusers, and panel warming systems; the Equipment and Engineering Company, Ltd., Norfolk-street, London, W.C.2, electro-magnetic crack detector; Geo. Bray and Co., Ltd., Leeds, 2, electric heating elements; the Cape Asbestos Company, Ltd., of 26–30, Holborn Viaduct, London, E.C.1. insulating material, jointings, and packings; Bell's Asbestos and Engineering Supplies, Ltd., of Slough, engine-room specialities; and Trier Brothers, 36, Victoria-street, London, S.W.1 lubricators, split grip collars, and "Talisman" cleanser.

Development of Cross-Channel Steamers.*

By MAURICE E. DENNY, C.B.E., S.B.

In tracing the development of the cross-Channel boat during the past thirty-five years, it is convenient to look first at the picture presented about the year 1900.

At the beginning of the century there were in commission paddle boats and twin-screw vessels with steam reciprocating engines.

Though the paddle boat was still well represented in numbers, it was scarcely holding its own. The London and South-Western Railway had not built one since 1875; the London and North-Western Railway not since 1884. Nevertheless, many notable examples could be cited. In length they varied from about 280ft. up to 360ft. The engines were usually of the diagonal type, either compound or triple-expansion, but the oscillating cylinder was not yet a thing of the past—indeed, powerful ships still depended on it. The "Mona's Queen," for example, of the Isle of Man Company, had compound oscillating engines developing 4500 i.h.p., and it is of interest to record that the steam supplied to them was superheated. The "Empress Queen," owned by the same company, was probably the highest powered cross-Channel paddler ever built. Her three-crank compound engine developed 10,000 i.h.p., while one paddle shaft and wheel alone weighed no less than 70 tons.

Steam pressures averaged about 140 lb. per square inch. A diameter of more than 9ft. for the low-pressure cylinder was not uncommon, and on trial about 9 s.h.p. per ton of machinery could be developed, though in the "Leopold II" this figure rose to 10·6.

Some of the foreign-built paddlers presented interesting features in their machinery. "Le Nord," built in 1898, had water-tube boilers with a working pressure of 186 lb. "Le Flandre," built for the Dover–Ostend service, had two piston valves to each high-pressure cylinder.

Speeds varied from 19 to 22 knots, among the highest being 22·2 by the "Leopold II." It should be remarked, however, that in those times trial speeds were notably greater than service speeds, the boilers being pressed on the measured mile to an extent which would not be approved to-day.

Turning to the screw boats, this type is seen strongly represented from the port of Southampton round to Fleetwood. Twin-screw three-cylinder triple-expansion engines were in the great majority, though a few four-cylinder triples can be recorded. The average steam pressure was about 160 lb. per square inch, and forced draught was generally adopted. Scotch boilers were dominant, though the French-built "Tamise" had Belleville boilers working at 240 lb. per square inch. Powers varied from 4000 to 7500 i.h.p., and speeds from 19 to 21½ knots. The range of length was somewhat more restricted than that of the paddle group, few exceeding 330ft.

On trial about 8·5 s.h.p. per ton of machinery was developed. It is a little surprising that this figure should be lower than that applicable to the paddle type of machinery. It should be noted, however, that the screw boats took steam from Scotch boilers, whereas the paddlers usually relied on lighter steam generators, such as the Navy type.

So far as the hull was concerned, the typical paddler gave the impression of a flush deck ship—sometimes with side openings—with some small houses on the weather deck. On the main deck might be a few private cabins for passengers disposed to luxurious travel, while the main saloons were lower still. The first-class accommodation was almost invariably aft. The typical first-class saloon had a double row of plush-covered settees round the sides, forming bunks or day beds. Indisposition, active or passive, was a public affair. The third-class travelled literally "hard." Electric lighting was introduced about 1889, but standby oil lamps persisted. In fine weather the weather deck was popular, but at other times voyagers were washed down below.

The screw steamer was generally modelled on the same lines, but a boat deck, usually short, was fitted amidships to make up for the deck space lost by the absence of sponsons. The screw steamers more usually served night passages than did the paddlers, and to some extent had more cabin accommodation, but single cabins were mostly for Royalty, and the voyager was fortunate who only had to share a "state room" with one or more strangers. The dormitory conception of night travel was still accepted, if not with enthusiasm.

Such, in brief outline, was the general situation about 1900. In this very year, however, took place an event which was profoundly to modify the whole outlook of the designer, for it was then that the contract was placed for the "King Edward," the first turbine passenger ship in the world. Her success, and the rapid rise to favour of the new prime mover, have been too often recorded to bear repetition in detail. For the channel boat the time was ripe for some revolutionary improvement in the qualities of propelling machinery, since both the paddle engine and the reciprocator, driving propellers, had practically reached the limit of their development. The South-Eastern and Chatham Railway, in 1903, in "The Queen," were the first to place a turbine steamer on Channel service. The machinery comprised three turbines, each direct coupled to a line of shafting, a high-pressure turbine in the centre exhausting into low-pressure turbines in the wings. This arrangement was the standard until the advent of gearing. In spite of the compromise, never entirely happy, between the conflicting demands of propellers and turbines in the matter of revolutions, this system is so simple and quiet, and so suitable to shallow draught, that it still persists, with justification, in river and estuary steamers.

During the first five years of the century a few paddle boats were built, mostly of minor importance, while the extension of the fleets of screw steamers continued. The turbine was rapidly proving itself; the fate of the paddler was sealed, and it was becoming clear that only in vessels of moderate speed could the new form of prime mover be denied.

In 1904 the "Princess Maud," a turbine vessel, was put on the Larne and Stranraer service. This fact is of interest, because her owners, the Portpatrick and Wigtonshire Railway, passed directly from the paddler to the turbine without having experience of the intermediate stage of screws driven by reciprocating engines. In that same year also the Midland Railway Company made an interesting experiment in their Heysham–Belfast service. They constructed three ships with similar hulls, two driven by reciprocating engines and one by turbines. If the verdict in that trial was not unanimous, as it would be to-day, it should be remembered that a machine in an early stage of development was pitted against one which had behind it long years of growth. It is sufficiently conclusive that practically no steam reciprocating driven ships of that type have been built since then. In passing, it may be noted that these craft were the first on Channel service to be fitted with forced ventilation to the passenger accommodation.

With very rare exceptions, the water-tube boiler had yet gained no footing; the Scotch boiler was practically supreme. Forced draught was almost universal, usually on the closed stokehold system. Oil fuel, of course, was unknown. In 1903 Sir John Biles stated in a paper before the Institution of Naval Architects that all British-built cross-Channel vessels were fitted with cylindrical boilers, and that they proved reliable in service. He added that the small number of water-tube boilers fitted required "frequent and prolonged intervals for recuperation."

The inherent suitability of the rotary engine for high

* The Institute of Marine Engineers, Tuesday, September 24th, 1935.

powers was quickly recognised. As early as 1905 the Belgian Government had built for the Dover–Ostend service a vessel propelled by turbines that developed 11,000 s.h.p., a higher figure than had ever been produced either by paddles or—for Channel work—by the reciprocating engine.

By the close of the first decade, the turbine was practically the unanimous choice for new ships, the three-shaft arrangement being universal. In 1910 the Isle of Man Company owned a vessel developing 14,000 s.h.p., which had a speed of 24½ knots.

Boiler pressures now averaged about 170 lb. per square inch.

In 1911 occurred two noteworthy events—the introduction of gearing, first employed on the London, Brighton and South Coast Railway service, and the change from Scotch to water-tube boilers (Babcock and Wilcox type) in the South-Eastern and Chatham Railway service.

The adoption of gearing so soon after the first trials in the "Vespasian" was a bold step, abundantly justified by its success, and by the substantial improvement both in propeller and turbine efficiencies, which indeed had been the origin of its introduction. It cannot be denied, however, that there was a drawback, namely, the hum or whine of the gears, which was sometimes evident and unwelcome, and no complete solution has yet been found. However, a great increase in the accuracy of gear cutting, coupled with improved methods of noise deadening, have gone a very long way to remove any real ground for criticism by the most fastidious passenger. In a vessel built in Belgium for the Dover–Ostend service, a Föttinger hydraulic transformer was fitted in lieu of gearing, but the experiment was not repeated.

The advent of the water-tube boiler was due, of course, to the desire to reduce weights, the marine engineer continually reaching out for more power per ton of machinery. In an installation of 10,000 s.h.p., about 200 tons might easily be saved, convertible either into a fuel saving of perhaps 15 per cent., or into an increase of speed of about half a knot.

In 1913 was constructed a notable ship, the "Paris," for the Newhaven–Dieppe service. The length was restricted by harbour facilities to 300ft., and the draught limited to 9ft. 6in., while a speed of 25 knots had to be shown on a double trial run between the terminal ports. This vessel had Yarrow type boilers, and was conspicuous as being the first ship in the world to use thrust blocks of the Michell type. For her size this vessel is also the fastest passenger ship in the world. A corresponding speed for the "Queen Mary" would be over 45 knots.

During this period the development of hull design and internal arrangement was gradual and less remarkable than in the machinery section. While the turbine drive abolished general hull vibration, the small fast-running propellers often caused considerable tremors at the stern of the ship. The design of rudders had to be overhauled, and both the amount of internal stiffening and of riveting at the after end had to be increased.

In a seaway the turbine tended to race very much less than did the reciprocating engine, and in consequence it was possible to maintain higher speeds in heavy weather. Local deck damage began to be recorded in way of forward hatches and bridge fronts, though it is noteworthy how much driving this class of lightly built ship will stand.

Deck erections tended to increase in number and extent. The boat deck, originally little more than a short platform to accommodate the lifeboats and the navigating bridge, now covered a considerable proportion of the ship's length. A bridge front with wings afforded greater shelter to passengers on deck. A range of private cabins often occupied the centre line, while a separate house aft protected the entrance to the third-class. By this time, the first-class accommodation had largely been shifted to forward and amidships, while to the third-class had been assigned that part of the ship which in a regime of propeller-driven vessels was apt to be less steady than in paddle craft. Open rails had to some extent given place to bulwarks, but the idea that a passenger, when not in a saloon or a cabin, should be afforded complete protection from rain, spray, and wind was still to germinate. More attention was being directed to lighting, heating, and ventilation, but the standard of comfort demanded by the travelling public on a Channel boat was still substantially less than was required of a first-class hotel ashore.

The sinking of the "Titanic" in 1912 was shortly to give rise to new legislation, which considerably increased the complexities of design of a class of ship already by no means easy.

During the Great War there was naturally a lull, both in construction and in development. Large numbers of Channel boats were withdrawn from their normal services, and reappeared in various guises as fleet auxiliaries of all kinds. As seaplane carriers, troopships, fleet tenders, and so on, they gave invaluable service, for which purposes their high speed rendered them particularly suitable. Several were lost; others were not worth reconditioning on their return after the Armistice. A notable feature of this interregnum was the fine performance of light-draught river boats, transferred from their normal sheltered waters to the much more rigorous conditions of English Channel work.

By 1921 the London and North-Western Railway had taken delivery of a fleet of four large and fast mail boats for their Holyhead–Dublin service. These ships were more than 390ft. in length overall, and remain the largest Channel boats in the world, though not the greatest in tonnage. A speed of 25 knots was required on trial. They were propelled by twin-screw geared turbines, steam being supplied at a pressure of 200 lb. per square inch by water-tube boilers. With a few outstanding exceptions, some of which persist to this day, this type of machinery has become the standard.

In 1923 the Southern Railway acquired new tonnage for their Channel Islands and St. Malo services, and again in 1929, and developed a class of vessel which completely remodelled this fleet. Propulsion was by twin screws, geared turbines, and Scotch boilers, though in the latest unit of this fleet, built in 1931, two Yarrow boilers supply steam in conjunction with one Scotch boiler, preheated air being fed to the furnaces of the water-tube generators. These ships, of moderate size, mark a stage in the progress of Channel boat design. In the machinery section they record the introduction of oil fuel, though it must not be inferred that this practice has been or will be followed by Channel boats on other services. Presumably a favourable price ratio between the liquid and the solid fuel at ports distant from coalfields was the deciding factor, but considerations of economy on short runs, flexibility in boiler-room control, and general cleanliness are also elements which cannot be neglected. Coal-burning Channel boats have recently shown a tendency to fit mechanical stokers, in view of the economy resulting from continuous firing and the possibility offered of using an inferior and cheaper grade of coal. Naturally the superiority of this form of firing shows up to greater advantage in long than in short runs, and it is therefore not surprising to find that the latest vessel to be placed on the Heysham–Belfast service—a six hours' run—is equipped with the mechanical gear.

On the hull side, these Southampton ships continued the "building up" process, and the general appearance of the craft began to resemble that of deep-sea passenger liners of many times their size. The boat deck was now continuous from the bridge front to the stern, and the sides were almost completely plated up. In addition, a large house made its appearance on the boat deck in front of the forward funnel, while the navigating bridge, wireless cabin, and captain's quarters were again a tier higher.

While discussing these craft, it is proper to point out that Channel ships, so far as their passenger arrangements are concerned, fall naturally into three classes—those engaged mainly on daylight routes, *e.g.*, Isle of Man and Dover–Folkestone services; those engaged on night routes, *e.g.*, Harwich and Heysham services; and those which run alternately by day or by night, *e.g.*, Southampton and Holyhead services. It will be readily understood that the problem of design is much simpler for either of the first two than it is for the last, where, indeed, the space available must be utilised to the uttermost, and difficult questions of compromise constantly call for settlement. That the compromise has not always been a happy one—especially from the point of view of the night traveller who often sought privacy in vain—can scarcely be denied, but it is generally admitted that the modern Channel Island ship is perhaps as near perfection as can be attained, at least until such a time as new methods or port facilities permitting increased dimensions of ship encourage another step forward.

In 1927 the London, Midland and Scottish Railway ordered three vessels for their Heysham–Belfast service. These vessels were 355ft. by 53ft., in contrast to the length of 330ft. and the beam of 41ft. of the vessels which had fulfilled the service requirements up to that time, and the tonnage increased by no less than 72 per cent. While the increase in length is 7½ per cent., it should be noted that the beam has increased by 29 per cent. The statical stability of the new vessels is little greater than that of their predecessors, which gives clear indication of the extent to which the building up process had been carried. In fact, these ships have a complete superstructure with two tiers of erections on top of it.

By now the single-berth state-room is common, and hot and cold running water is laid on to all rooms. The electric load has risen rapidly. Not only has the standard of lighting enormously increased, but steam has been supplanted for driving the steering gear, capstans, and windlasses, while forced ventilation and the various "hotel services" impose heavy demands for current. Wireless, echo depth sounders, and direction finders, all help the captain to ensure the safety of his ship, while the navigating bridge is a mass of instruments recording tiller angle, position of water-tight doors, engine revolutions, and sometimes even the speed of the ship through the water.

In 1928 the Southern Railway built a special ship for their Golden Arrow service. This *de luxe* vessel, the "Canterbury," carries a restricted number of passengers. Only a little longer than "The Queen" of 1903, she is 7ft. greater in beam. The wide promenades thus secured are completely protected from the weather—in contrast to earlier days there is now much more glass than steel in the erections—and the highest standard of comfort is satisfied. Private suites, luxurious armchairs in quantity, airy lounges, and good taste in all the appointments give striking evidence of the very great advance that has taken place in a quarter of a century.

In 1930 the London and North-Eastern Railway placed three fine new boats on their Harwich–Hook of Holland service. The water-tube boiler has not found favour with these owners, but in one of these ships the boiler pressure was raised to 250 lb. per square inch. Except for their dimensions, these vessels are truly passenger liners. Their gross tonnage of 4200 is the greatest yet attained by a Channel ship.

Two years later the Southern Railway augmented their Newhaven–Dieppe fleet. In length and draught, the new boat was much the same as the "Paris," but whereas that ship was 35ft. 6in. in beam, was coal fired, and had compound turbines taking steam at 200 lb. per square inch, the new boat was 38ft. 6in. in beam, was oil fired, and had triple-expansion turbines taking steam at 250 lb. per square inch, while preheated air was supplied to the boilers, which worked under balance draught. The gross tonnage of the new boat was 34 per cent. greater than that of the "Paris."

It is necessary now to turn back three years to chronicle an epoch-making event in Channel boat history, a change more revolutionary than the advent of the turbine. For while the turbine swept all other steam engines from its path, it still relied on the same working fluid as did those it supplanted.

The internal combustion oil engine banishes both turbines and boilers.

In 1929 three vessels driven by oil engines were put on service between Liverpool and Belfast by the Belfast Steamship Company. These ships, which bear a strong resemblance to much larger motor liners, are 350ft. in length, and are propelled by oil engines driving twin screws, the aggregate shaft horse-power being about 6000. Each engine has ten cylinders, the revolutions at full speed being 160 per minute. Unfortunately, the introduction of the oil engine marks the return of an old affliction, namely, vibration, a trouble which the turbine had largely exorcised. Channel boats are of necessity lightly constructed, and, if the oil engine is to find wide application in them, engineers are faced with the task of producing a machine which in operation shall not have large free forces or couples of any order. It is useless and wrong for the marine engineer to ask the naval architect to produce a structure which shall not vibrate in resonance with the disturbing forces of the engine, though he is entitled to call for adequate scantlings and the best of workmanship. The disease should be cured; the shipbuilder should not be required to mask the symptoms.

Vibration is one of the most distressing defects to which a ship can be subject, and the travelling public of to-day is intolerant of this in a much higher degree than ever before. Good hope that the problem is soluble is encouraged by the standard attained in two other oil-engined Channel boats built in 1934 and 1935 respectively, one of which at least is practically as free from vibration as the best turbine.

The first of those mentioned above is the "Prince Baudouin," built in Belgium for the Dover–Ostend service. This notable vessel is about 360ft. in length, and is propelled by twin sets of oil engines, each set having twelve cylinders. The aggregate power is 16,000 s.h.p. at about 260 r.p.m., with which a speed of over 25 knots was attained on trial.

The other is the "Queen of the Channel," put on service this year between the Thames and Continental ports by her owners, the London and Southend Continental Shipping Company. This ship, a day excursion vessel, is 255ft. in length, and is propelled by twin sets of oil engines, the aggregate power being 3000 s.h.p. at 300 r.p.m., giving a speed on service of 19 knots.

With the exception of the vessels named, the normal machinery picture of the present-day cross-Channel steamer shows twin screws driven by geared turbines, steam being supplied usually, but not invariably, by water-tube boilers at a pressure of 250 lb. per square inch. Superheat and air preheating are unusual, though not unknown. Coal and oil are both used as fuel, mechanical stokers being occasionally employed in the former case.

As regards hulls it should first be noted that the average length of the present-day Channel boat is little greater than was the case at the end of last century. Terminal facilities in this respect have a powerful influence, but narrow harbour entrances and tortuous channels also discourage increase in length as tending to less handiness in manœuvring.

Except on certain services, such as Newhaven–Dieppe, the average speed also has not been substantially increased, though the average power has certainly risen. The increase in power has been largely absorbed in maintaining the old speeds at greater displacement on the same length. On many night services acceleration is not called for. The present hour of departure is not too early, nor is the hour of arrival too late. Few people wish to have less than seven hours' sleep. Another reason for reluctance to increase speed is the great cost of doing so. In a typical Channel boat, such as is employed on the Calais–Dover service, the power increases as about the fifth power of the speed. Now, to cut five minutes off a run of 60 minutes means a speed increase of 8½ per cent., which calls for a rise of about 60 per cent. in the power, allowing for an increase in the weight of machinery. Is the game worth the candle?

As compared with last century, the specific weight of machinery has been much reduced. A typical paddler developed about 9 s.h.p. per ton of machinery; the corresponding figure for the reciprocating screw-driven ship was about 8·5 s.h.p. The modern turbine vessel gives about 15 s.h.p. per ton of machinery, though this figure may rise as high as 34 s.h.p. in certain special cases.

On the other hand, the hull weight has greatly increased, and has much more than absorbed the saving in machinery. Legislation following the "Titanic" disaster substantially increased the weight of hull. More and heavier bulkheads were required, more boats and other life-saving appliances, emergency pumping and lighting, and so on. The new regulations, in fact, regarded the Channel boat as being engaged on a service of special risk, and special precautions were enforced. Again, the disappearance of yellow pine, a wood of light weight, involved considerable increases in the weight of decks. The demand for greater comfort, single-berth state-rooms, enclosed promenades, and ampler public rooms, increased the extent, height and weight of top hamper, when for stability reasons the beam had to be increased—again more weight. Running water to all cabins, forced ventilation, wireless, a sprinkler system of fire detection and extinction, and many other innovations too numerous to mention, have all contributed to a rise in the weight of hull. As a rough average figure, it would be fair to say that for the same length and draught the present-day Channel boat has not less than 25 per cent. more displacement than her prototype of 1900. The increase in hull weight is not less than 50 per cent.

What is the future of the Channel boat? The Southern Railway has just acquired three ferries to transport train-loads of goods to the Continent without breaking bulk. With the introduction of these craft a sleeping car service from London to Paris is in sight. In the air the numbers of passengers carried to the Continent rises steadily year by year, and services to the Channel Islands and to Northern Ireland are already in operation, while others are contemplated. Prophecy is notoriously foolish, but for some time yet to come it does not seem likely that air travel will make really serious inroads on the yearly volume of cross-Channel passenger traffic, taking Britain as a whole.

In the technical sense the field is as ripe for labour as ever it was. There is no stagnation in design, and the mental alertness of our naval architects and marine engineers is a sure guarantee against the decadence which attends lethargy. That progress in the engine-room and the boiler-room (if the latter continues to exist) will be maintained is certain, for which the wisdom and ability of designers, and the experience and skill of operators, will be responsible. The Institute of Marine Engineers should take an important part in these developments. With its history and its present vigour there can be no doubt that it will do so.

Figures published towards the end of September indicated that the electrification of the Italian State Railways has resulted in an annual saving of 1,100,000 tons of coal. Further electrification on the lines from Florence to Rome and from Rome to Naples will effect a further saving of 230,000 tons.

Rail and Road.

DRIVING the 500 h.p. Napier-Railton motor car in which he recently broke the world's twenty-four hours and several other speed records in America, Mr. John Cobb has regained the Brooklands outer circle lap record with a speed of 143·44 m.p.h. He also established a new flying kilometre record at the highest speed ever reached at Brooklands, 151·97 m.p.h.

DURING a dense fog on Monday, October 7th, a motor lorry, descending a hill towards the public road level crossing at Buckhurst Hill, L.N.E.R., crashed through the gates, which were closed against road traffic, and came to rest on the crossing. The gates were shut because of the approach of a passenger train, which collided with the lorry. The driver of the latter heard the train coming and jumped clear.

THE Yugoslav Minister of Transport has authorised an international competition for a design for the building of a new railway bridge over the river Sava, near Zagreb. Conditions of entry, in Serbo-Croat, French and German, may be obtained from the Finance Department, Directorate of State Railways, Beograd, Yugoslavia, or from the Cashiers Department, State Railways, Zagreb, Yugoslavia, at a cost of 48 dinars. The prizes are as follows:—First prize, 60,000 dinars; second prize, 40,000 dinars; third prize, 20,000 dinars; and three prizes of 10,000 dinars each for the purchase of other designs. Entries must be submitted by January 11th, 1936, at latest.

IN a paper submitted to the Highway Research Board by Professor R. L. Morrison, of the Department of Highway Engineering at the University of Michigan, U.S.A., the effect of road width upon accidents is discussed. The opinion offered is based upon investigations of several portions of roads, and it is claimed that the desirability of building 20ft. roadways rather than narrower ones to carry two lines of traffic has been proved. According to the author, the accidents directly attributable to road width on two lengths of road, 20ft. and 18ft. wide, were 1·00 per mile and 1·70 per mile respectively. On the ground of grossly careless driving the figures given are 0·53 per mile and 1·10 per mile respectively. The figures, of course, relate to a single year.

IN an intimation that the Southern Railway Company's private telephone exchange would, on October 1st, be transferred from the Hóp to the Waterloo Post Office Exchange, it was stated that it was the first automatic exchange to be introduced by any British railway. As the main credit for that belongs to the late Mr. W. J. Thorrowgood, the then signal and telegraph superintendent of the Southern Railway, we would like to repeat some of the details supplied by that gentleman in an article he contributed to the December, 1925, issue of the *Southern Railway Magazine*. In 1921 a 50-line sytem was installed at Waterloo, and in 1923 a 200-line equipment—by 1925 extended to 400 lines—was provided at Southampton Docks, together with a 60-line system at Eastleigh. These proved so successful that in October, 1925, an automatic telephone system for the inner London area was installed, which provided intercommunication between all the offices, stations, and depôts of the company in the London area. During 1934, no fewer than 335,713 outgoing calls were dealt with by this exchange; the incoming calls ran into millions.

SOME records for oil-engined motor cars of the 3-litre class were set up at Brooklands on Wednesday, October 9th, by Mr. R. Munday driving a Perkins-engined "Thomas Special" car. The engine adopted is manufactured by F. Perkins, Ltd., of Peterborough, and is the standard model fitted to 2½-ton lorries by the firm. It has been tuned, reciprocating parts have been lightened, and a supercharger has been fitted to come into action when required by the driver. The engine gives nearly 65 b.h.p. at about 4000 r.p.m., with a b.m.e.p. of 125 lb. per square inch. The chassis is a Thomas Special, and the top gear ratio used is 2·4 to 1 with 27in. tires. The supercharger is a standard design, giving up to 0·5 atmosphere pressure, claimed to increase the b.h.p. by 30 per cent. The Perkins engine has been described on several occasions in THE ENGINEER. The records set up on October 9th were:—The Flying Kilometre at 23·62 sec.; 50 Kilometres at 88·11 m.p.h.; 50 Miles at 88·44 m.p.h.; 100 Kilometres at 88·38 m.p.h.; 100 Miles at 88·13 m.p.h.; and One Hour at 88·25 m.p.h. The car ran with commendable regularity.

YET another accident at a level crossing has been reported upon. On this occasion a passenger train ran into some cattle at an occupation crossing, with the result that the trailing bogie of the first coach was derailed. There were no personal injuries and practically no damage was done to the train, but four cows were killed and two others had to be destroyed. The scene of the accident was 907 yards north of Pontsarn Station up starting signal and 1246 yards south of the up hand signal for the West box at Peterston Station, between Cardiff and Swansea, on the Great Western main line. The mishap occurred on July 15th and the present report is by Colonel Trench. The cattle had to cross from the down to the up side and the man in charge complied with all the regulations, *e.g.*, he opened the farther gate first and looked in each direction. The man, who impressed Colonel Trench as being of an unusually alert and intelligent type, laboured, however, under two disadvantages: (1) he usually crossed a little after 9 a.m., when he knew by experience that there was a gap between the trains, but he did not know that, when the summer train service was inaugurated a week before, this particular train commenced to run five minutes earlier; (2) he did not know that the nearby distant signals were not stop signals and that their being in the "on" position did not necessarily mean that no train was approaching. Recommendations as to advising the users of crossings as to these two points are made by Colonel Trench, but his most important recommendation reads as follows:—It is clear that under normal conditions cattle can cause derailment of a locomotive-hauled train; it would appear that this risk is likely to be substantially greater in the use of multiple-unit trains, the use of which is now extending into country areas, where cattle crossings are more frequent than in the suburban areas to which this type of train has hitherto been confined.

Miscellanea.

IT is expected that test television transmissions will be able to be made from Alexandra Palace next March.

AN experiment with a machine for sorting letters is being carried out at Brighton Post Office by the G.P.O. The machine is said to have an output of 24,000 finally sorted letters an hour.

AT a meeting of the British Engineers' Association, held in London on Thursday, October 10th, Major H. B. Riggall, commercial manager of Ruston and Hornsby, Ltd., was elected a member of the Council.

TO mark the progress of research in industry during the twenty-five years of the King's reign, a committee under the chairmanship of Sir Harry McGowan is making arrangements for a banquet on November 22nd.

A MESSAGE from Auckland, N.Z., in the *Iron and Coal Trades Review*, states that a new bridge is to be built over Auckland Harbour. The cost is estimated at £1,250,000, and an agreement has been signed with Australian financiers for its financing and construction.

WHEN a number of small electrification schemes in Japan have been finished it is planned to electrify the Tokaido main line from Numazu, the present electric terminus, to Kobe, a distance of 286 miles. The conversion will be completed by 1941, at an estimated cost of 50,000,000 yen.

THE Ministry of Agriculture and Fisheries has approved of a scheme for the complete reconstruction of the sea wall at Hythe, Kent, and the building of thirty-three new groynes, at a cost of £55,350. The work will take over a year to finish, and is expected to give employment to several hundred men.

THE Council of the Institution of Electrical Engineers has arranged for alterations to be carried out to the heating system of the Institution building at the end of the present session. The existing coal-fired boilers will be replaced by an electrode boiler with thermal storage vessels, and the temperature of the building will be thermostatically controlled. The ventilation system of the Lecture Theatre will also be completely remodelled so as to provide an ample supply of clean, fresh air.

A TABULATION of installed and potential horse-power in 107 countries, issued by the U.S. Geological Survey, shows that existing developments total about 55,000,000 h.p., while the aggregate of potential power is 472,000,000 h.p. The latter estimate is based on ordinary low water and an efficiency of 70 per cent. in the plants. Since installations average two to three times the potential power at low flow at the same sites, ultimate developments in excess of 1,000,000,000 h.p. are possible.

IN a recent paper before the Institution of Chemical Engineers on "Modern Methods of Welding," Mr. C. H. Davy said that the good mechanical properties of an atomic hydrogen weld may be seriously affected if the source of hydrogen supply is unsatisfactory. Hydrogen produced by electrolysis of ammonia, if used for this purpose, is liable to produce welds containing an undesirable percentage of nitrogen, which will have an adverse effect on the resistance to age-hardening and fatigue.

IN an inquiry concerning an outbreak of fire in the liner "Baarn" in June last whilst on a voyage from the West Coast of South America, the Netherlands Court of Navigation found that the fire must be attributed to spontaneous combustion of the tin ore, in spite of the fact that expert evidence submitted was to the effect that pure tin ore, viz., SnO_2, was not liable to spontaneous combustion. Analyses of samples from the ore carried in the ship disclosed that this ore contained 21 per cent. pure tin, the impurities including sulphur and pyrites.

AN American company experienced difficulty in breaking up insulating compound which solidified at normal temperatures, and was delivered to the works in barrels in solid form too large to be handled. The method which the firm eventually used is described in the *Electrical World*. A heavy angle iron frame was constructed, across which two heavy nichrome heating strips were attached vertically and with such separation as to divide the area into three parts. With this device energised and set on top of the barrel-shaped mass of material, the heating elements, plus the weight of the frame, cut through the material quickly, dividing it into portions which could be easily handled.

THE Official Returns rendered to the Electricity Commissioners show that 1320 million units of electricity were generated by authorised undertakers in Great Britain during the month of September, 1935, as compared with the revised figure of 1142 million units in the corresponding month of 1934, representing an increase of 178 million units, or 15·6 per cent. The number of working days in the month (*i.e.*, excluding Sundays) was twenty-five, the same as last year. During the first nine months of 1935 up to the end of September, the total amount of electricity generated by authorised undertakers was 12,227 million units, as compared with the revised figure of 10,875 million units for the corresponding period of 1934, representing an increase of 1352 million units, or 12·4 per cent.

ACCORDING to a note in *O'Connell's Coal and Iron News*, Oldham Town Council is to consider at its next meeting a proposal to sell the Pennine reservoir, which cost £600,000 to build. This apparently drastic step is contemplated because it has been found that the town could more economically obtain its needs from water which has accumulated in a disused colliery. Some time ago the Corporation acquired the flooded Butterworth Hall Colliery, and began to pump water to augment the ordinary supply. At present it is estimated that no less than a million and a half gallons are running to waste every day from this source, and it is contended that the whole of the town's needs could be met from these underground reserves at a comparatively small expense. The cost of making the necessary borings and conversions would amount to no more than £40,000, on which the annual charges would be trifling compared with the present annual liability of £33,000 in connection with the existing supply.

Air and Water.

THE 16,000-ton Cunard White Star liner "Doric" is to be sold for breaking up.

A NEW air service between London and Lille, operated by British Continental Airways, has been inaugurated.

ADDITIONAL works at Roundhay, Leeds, are to be opened by the Blackburn Aeroplane and Motor Company, Ltd.

THE Cunard White Star liner "Olympic" has completed her last voyage to Jarrow, where she will be broken up.

IT is reported that an order for aeroplanes to the value of £50,000 has been placed with A. V. Roe and Co. by the Greek Government.

A BILL has been brought before the Argentine Congress in order to provide some £290,000 for the improvement of the shipyards at La Plata.

A WORLD record is claimed by a Czechoslovakian lieutenant named Pawlowsky, who recently made a parachute jump of 28,770ft.

A FACTORY is to be built by Boulton Paul Aircraft, Ltd., adjoining the municipal airport now being constructed at Barnhurst, Wolverhampton.

THE hulk "Hygeia," which has for many years served as the floating headquarters of the Port of London medical staff at Gravesend, is to be replaced by an Admiralty steel lighter.

ONE passenger was hurt when the Imperial Airways liner "Syrinx" from Cologne landed at Haren aerodrome, near Brussels, and was blown over on her side by a violent squall and badly damaged.

IT is announced by the United States Navy Department that during the fiscal year 1937 one battleship, twelve destroyers, and one submarine are to be constructed. The U.S. Navy's enlisted strength will be increased to 100,000 men.

THE first of three new flying boats for the Pan-American Airways trans-Pacific service was recently handed over to the company. The machine, which is some 90ft. long with a wing span of 130ft., made a demonstration flight carrying thirty-eight passengers and a crew of five.

FROM October 1st until October 13th, the Suez Canal receipts amounted to some £500,000, representing a rise of £54,000 over receipts for the same period of last year. The number of ships passing through the Canal increased from 4196 during the first nine months of 1934 to 4347 during the same period of 1935.

IDLE tonnage has considerably decreased at the Welsh ports, on the Tyne, and on the Wear. In the Welsh ports only nine British vessels are laid up, as against nearly half of the entire fleets two years ago. On the Tyne there are forty-eight vessels laid up, as against 182 two years ago, and on the Wear five vessels are laid up, as against twenty vessels eighteen months ago.

THE first of a series of lectures to perpetuate the memory of the late Air Vice-Marshal Sir W. Sefton Brancker, who was President of the Institute of Transport for the year 1928–29, will be delivered by Lieut.-Colonel F. C. Shelmerdine, Director-General of Civil Aviation, on Wednesday, October 30th, 1935. The subject of the lecture will be "Air Transport in Great Britain: Some Problems and Needs."

SHIPPING tonnage dealt with at Southampton docks in the first eight months of the present year exceeded by 8 per cent. that for the corresponding period of 1934. The tonnage returns show that the gross tonnage inward amounted to 12,100,122 tons during the period January–August inclusive this year, as compared with 11,223,228 tons, whilst outwards the return was 12,244,332 tons, as against 11,383,007 tons in 1934.

THE Orient Steam Navigation Company, Ltd., has placed a contract with Vickers-Armstrongs, Ltd., to construct another turbine-propelled liner of similar size and power to the "Orion" for the Australian mail service. The general arrangement of the new ship will be modified in the light of recent experience. The "Orion," which was described in THE ENGINEER of August 23rd and 30th, 1935, has a gross tonnage of 23,371 and is the largest vessel engaged in the Australian trade.

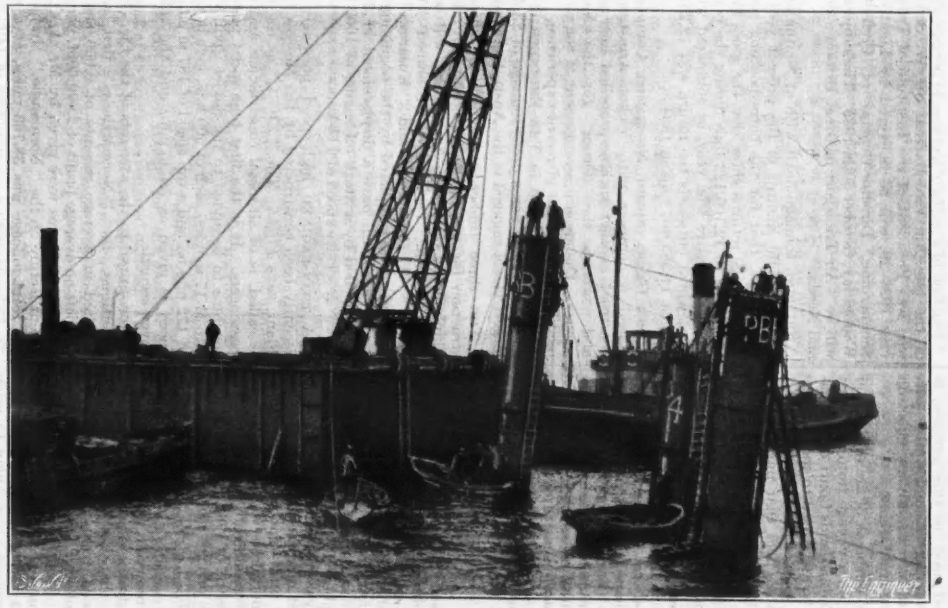
THE three timber-carrying motor ships under construction for the Soviet authorities by the Netherland Shipbuilding Company, Amsterdam, will be launched on October 26th. They are to be named "Walerii Mechlank," "A. Andreew," and "Kosarew" respectively, and are to be completed by the beginning of next year. Each vessel will have a displacement of 3635 tons, and be propelled by a Stork oil engine of 1000 b.h.p. in each case. A service speed of 11½ knots is expected.

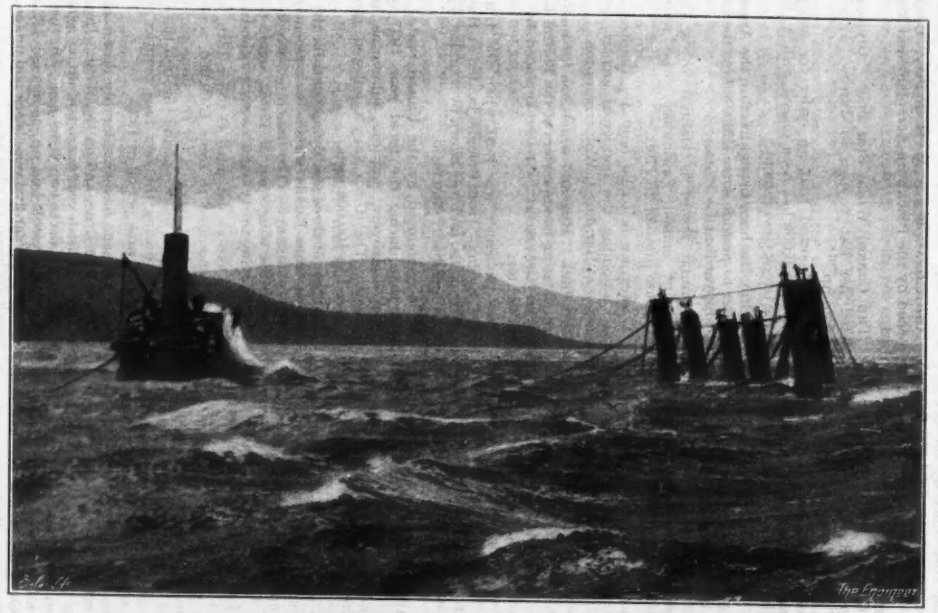
A TWIN-ENGINED high-speed passenger machine has recently been constructed by the Moscow Civil Air Fleet Plant, says *Flight*. The "ZIG-1," as the new aeroplane is called, is of all-metal construction and carries twelve passengers. It is the first high-speed passenger type of machine to be added to the Soviet Civil Air Fleet. The two M-17 motors, each of 500 h.p., give it a cruising speed of 172 m.p.h., and a top speed of 187 m.p.h. The landing speed is given as 50 m.p.h., and the take-off time as seven seconds.

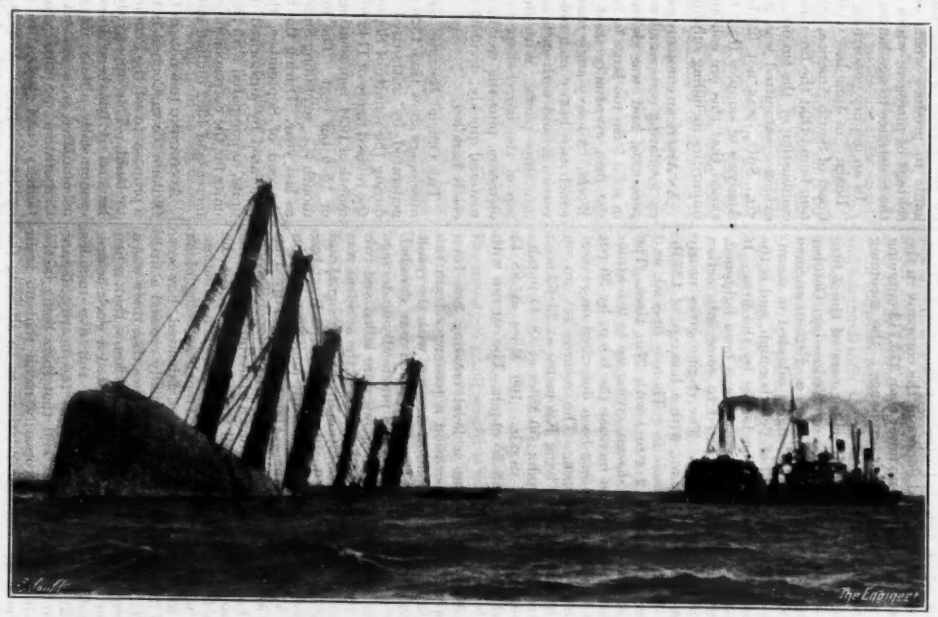
ACCORDING to the accounts of the Cie. Générale Transatlantique, the "Normandie's" first seven voyages resulted in average receipts of 6,000,000f. per voyage, and left an average profit of 2,000,000f. per voyage. Some interesting figures were given by Mr. A. C. Hardy in his recent lecture on the "Normandie." In her first six trips her total mileage was 38,763 miles, at a mean speed of 28·55 knots, with a consumption of 1492 kilos. of oil per mile. Her best mean speed on her first westbound trip was 29·53 knots, with a best day's run of 753 miles, the highest speed attained being 31·37 knots. The best mean speed eastbound was 30·34 knots, the highest speed being 30·91 knots, and the best day's run 711 miles. After one more return trip to New York, due to be completed on October 28th, the vessel will be taken to Saint Nazaire for overhaul.

SALVING THE EX-GERMAN BATTLESHIP "KONIG ALBERT"

(For description see page 396.)







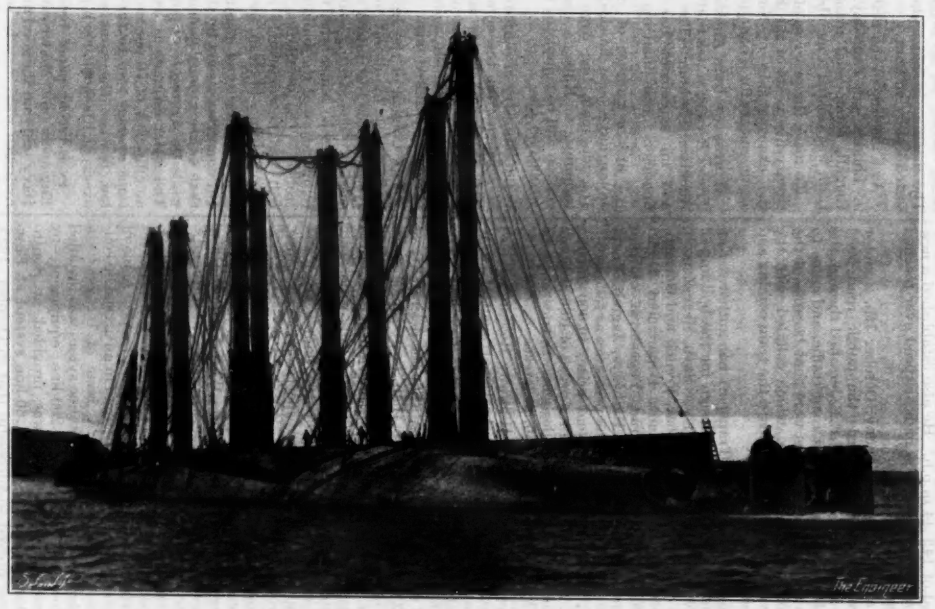


FIG. 8 (ABOVE)—PONTOON IN POSITION OVER WRECK
FIG. 9 (BELOW)—BOW OF WRECK RAISED

FIG. 10 (ABOVE)—OPERATIONS INTERRUPTED BY GALE
FIG. 11 (BELOW)—THE SHIP SHORTLY AFTER BEING RAISED

The Engineer

OCTOBER 18, 1935.

VOL. CLX. No. 4162

Contents.

THE ENGINEER, October 18th, 1935. PAGE

A SEVEN-DAY JOURNAL ... 393
DYNAMOMETERS FOR AGRICULTURAL RESEARCH. No. III. (Illus.) ... 394
THE CAPE COD CANAL. No. II. (Illus.) ... 395
SALVING THE EX-GERMAN BATTLESHIP "KONIG ALBERT." (Illus.) ... 396
THE MOTOR SHOW AT OLYMPIA. No. I. (Illus.) ... 398
SHIPPING, ENGINEERING AND MACHINERY EXHIBITION AT OLYMPIA. No. VI ... 400
DEVELOPMENT OF CROSS-CHANNEL STEAMERS ... 401
ROAD AND RAIL—MISCELLANEA—AIR AND WATER ... 403
LEADING ARTICLES—
Rebuilding the Navy—Railway Accident Reports ... 405
LITERATURE ... 406
SHORT NOTICES ... 407
BOOKS RECEIVED ... 407
LETTERS TO THE EDITOR—
Industrial Competition with the Far East—Fast Trains ... 407
A SOUTH AFRICAN SEWAGE DISPOSAL SCHEME. (Illus.) ... 408
THE "RELATOR" SPEED CHECKING SYSTEM. (Illus.) ... 409
PROGRESS OF SHIPBUILDING ... 409
ROAD RESEARCH BOARD REPORT ... 410
SIXTY YEARS AGO ... 410
NEW DISCHARGE LAMP ... 410
A NEW MOTOR STATOR. (Illus.) ... 411
VERTICAL SHAFT WORM REDUCING GEARS. (Illus.) ... 411
CANADIAN ENGINEERING NEWS ... 411
POWER IN STEEL WORKS ... 412
STRENGTH AND FLEXIBILITY OF CORRUGATED PIPING. No. V. (Illus.) ... 412
WORLD CONSUMPTION OF ELECTRICAL ENERGY ... 414
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 414
LAUNCHES AND TRIAL TRIPS ... 414
MARKETS, NOTES AND NEWS ... 415
CURRENT PRICES FOR METALS AND FUELS ... 416
FRENCH ENGINEERING NOTES ... 417
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 417
FORTHCOMING ENGAGEMENTS ... 418
CONTRACTS AND ORDERS ... 418

ONE-PAGE SUPPLEMENT—PENCIL PORTRAIT No. III: "SIR JOHN A. F. ASPINALL, D. ENG."

NOTICES TO READERS.

**** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

**** *For Subscription rates, see page 2 of Advertisements.*

**** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

**** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

CHANGES OF ADDRESS.

**** *Will subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Pencil Portrait No. 3.

With this issue we present the third of our Pencil Portraits. It is of Sir John A. F. Aspinall, D.Eng., Past-President of the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Institution of Civil Engineers of Ireland and late Chief Mechanical Engineer and General Manager, Lancashire and Yorkshire Railway.

REBUILDING THE NAVY.

A SUBSTANTIAL increase in the strength of the Navy, both in *materiel* and *personnel*, is understood to have been definitely decided upon by the Government. Whether appropriate action is to be taken in advance of the lapse of the Washington-London treaties at the end of next year is not yet known outside official circles. It is, however, not improbable that the march of events will compel us to such action at an early date. Recent developments abroad have given the nation a salutary reminder of its absolute dependence on the Navy, not only for the safety of trade routes and oversea possessions, but for the fulfilment of that peace policy which the whole Empire is determined to pursue. Peace hath its risks, scarcely less great than those of war. In defence of peace we are compelled to undertake grave responsibilities. To do so without a sufficient reserve of armed strength to compel respect would be to defeat the very purpose we have at heart. First and foremost the Navy must be made strong enough to deter aggression from any quarter. Air power in itself is not enough, its influence being purely local unless it can be extended by means of seaborne transport, and that, in turn, implies command of the sea routes. While, therefore, the expansion of the Royal Air Force now in progress is necessary for home defence, the claims of the air arm must never be allowed to override those of the Navy.

The Admiralty, no doubt, has already prepared its plans for rehabilitating the Navy as soon as Parliamentary sanction is forthcoming. These plans must of necessity remain somewhat nebulous until the next meeting of the Naval Powers clarifies the situation. According to present indications an extension of existing limitation treaties is out of the question. Denounced formally by Japan, and informally, but no less emphatically, by France, the old system of restriction by ratio seems doomed to expire on December 31st, 1936. What is to take its place? So far the only alternative is that suggested by the British Government and explained in Parliament recently by the First Lord of the Admiralty. Under this system the Powers concerned would announce their respective building programmes for a term of years and bind themselves not to exceed the specified aggregates of tonnage save in exceptional circumstances. Whether such a method would really function as a brake on competitive building seems to us doubtful. How can one Power, say, Great Britain, publish a building programme to cover five years without first knowing something of the intentions of other Powers? It is understood that British naval policy in recent years has been based on a one-Power standard, the denominator being the United States Navy—not because the United States has ever been, or ever can be, regarded as a potential enemy, but simply because her naval forces are the strongest of any foreign Power. But is the strength of the American Navy a suitable "yardstick" with which to measure British needs? We have never believed it. American naval problems differ radically from our own. Almost the only sphere of naval and strategical interest to the United States is the Pacific. From the Atlantic there is no conceivable menace to American interests. It is as difficult to imagine a fleet from Europe crossing the Atlantic to attack American territory as to picture the invasion of Canada by some European or Asiatic Power. To state the matter bluntly, but accurately, either contingency would bring a third party into the field, not because of any formal alliance or treaty, but for the sufficient reason that Great Britain and the United States have a common interest in maintaining, at all costs, the *status quo* in the Western Hemisphere. That is the one dominant fact that reduces to absurdity every suggestion, whether made from ignorance or malice, of rivalry between the naval policies of the two English-speaking countries.

On the other hand, we must face the fact that the United States holds fast to the principle of equality in sea power with the British Empire, a principle which has been accepted by this country. But whether the full implication of that agreement is realised on the other side of the Atlantic is questionable. It does not mean, as some American spokesmen have intimated, that a figure of combatant tonnage which satisfies American requirements must necessarily be adequate for the British Empire. Our strategic interests are not confined to the Pacific; they extend, also, to the North Sea and the English Channel, the Mediterranean, and the Indian Ocean. It is impossible for us to concentrate, as the United States has virtually concentrated, 90 per cent. of the national naval strength in a single area. Free and secure sea routes are more vital to us than to the United States. At a pinch that country could feed itself and keep its industrial machinery running—at much reduced *tempo*, it is true—for an indefinite period even if its seaborne trade were at a standstill. We, on the contrary, would, in like circumstances, be reduced to starvation and utter ruin in less than three months. In other words, adequate naval strength, although essential to both countries, is in the final analysis more important to Great Britain than to the United States. Hence our claim that to Great Britain should be left the determination of the total tonnage figure to which each of the two navies is to be restricted. There need be no fear that this figure will be an unnecessarily large one. Great Britain may be solvent, but she has not a penny to waste. It has been officially announced, and not a day too soon, that the Navy is to be rebuilt. When that process begins it will be found that every item of expenditure has been cut to the absolute minimum consistent with the purpose in view. The heaviest burden will be the replacement of our battle fleet. At the end of next year twelve of our fifteen capital ships will have passed the age limit of twenty years. Large sums of money have been, and are still being, spent on renovating these old vessels, but there is a point at which "modernisation" ceases to pay. However much we may patch up a ship of the "Queen Elizabeth" or "Royal Sovereign" class, it must remain greatly inferior to the new battleships now being built abroad. When the time comes to lay down new capital ships they will probably be found to be units of 35,000 tons, corresponding to the ships which France and Italy have already begun or ordered, and to those projected by the United States. It would, in our judgment, be a serious mistake to accept a lower standard of power than that represented by the latest foreign construction. Fortunately, there is no reason to anticipate that the existing maximum of 35,000 tons will be exceeded. For the United States the dimensions of the Panama Canal locks are a determining factor in man-of-war design, for which reason American naval experts are not likely to advocate an increase on the present standard. As for cruisers, the largest now being built are of 10,000 tons, and here, also, the limit has probably been reached. The latest British cruisers, "Southampton" type, of 9000 tons, are a compromise between the U.S. "Brooklyn," of 10,000 tons, and the Japanese "Mogami," of 8500 tons, but as against the fifteen 6in. or 6·1in. guns mounted in the American and Japanese ships, the "Southampton" is to carry only twelve 6in. So far as this country is concerned, cruiser design is in a state of flux. It has been admitted by the Admiralty that the "Southampton" and her sisters were planned as a counterweight to the U.S. and Japanese vessels, but no one pretends that the type is ideal for British requirements. Not only is it too expensive, but the tonnage is excessive for a 6in. armament. We hope, therefore, that, after the eight "Southamptons," a reversion will be made to a modified "Leander" type, displacing about 8000 tons. Since the triple mounting for 6in. guns has been adopted in the "Southampton" group, for the first time by the British Navy, an armament of nine 6in. would appear to be suitable for the later and smaller ships. Vessels of this type would be equally useful for fleet or trade-protection duties.

Up to now the Admiralty has turned a deaf ear to proposals for building convoy sloops of a type exempt from treaty restrictions. These ships would be of not more than 2000 tons, with a speed of 20 knots or less, and a main armament of three or four 6in. guns. They would be relatively inexpensive, yet incomparably more useful in war and peace than the 1060-ton sloops of which nearly thirty have been built in the past eight years. The nearest approach to the class proposed is the "Enchantress," of 1190 tons, 18 knots, and four 4·7in. guns, one of which has been temporarily suppressed to make room for extra cabins, since the "Enchantress" serves on occasion as an Admiralty yacht. As the need for well-armed convoy escorts is manifestly real and urgent, it would be interesting to learn why the Admiralty still hesitates to build them. Turning to destroyers, we hear unofficially that the units of the 1935 programme, for which tenders are shortly to be invited, will be superior in tonnage and armament to those now completed or being built. The latter are ships of 1375 tons, mounting four 4·7in. guns. Foreign torpedo vessels now in hand are much more powerful. The thirty-two French flotilla leaders have an average displacement of 2432 tons, and in the majority an armament of five 5·5in. guns. Japan has completed twenty-four ships of 1700 tons, mounting six 5in.; the latest U.S. leaders and destroyers have a standard armament of five 5in., as have also the sixteen new German destroyers of 1650 tons. In these circumstances an increase in the size and fighting power of British destroyers would appear to be a measure of common prudence.

The time has come, in fact, to overhaul our naval defences from top to bottom, and to reorganise and rebuild to suit our own requirements. Adhesion to one-sided treaties and the vicious principle of unilateral disarmament has brought us to a pass which is admitted on nearly all sides to be a serious one. A large programme of new construction, covering several years, is certain to be introduced at an early date. That it will cost a great deal of money goes without saying. Yet "defence is more than opulence," as Adam Smith said, and it is a consoling reflection that at least 80 per cent. of the monies we are about to spend on putting our sea defences in order will go into the pockets of British workers.

Railway Accident Reports.

ONE of the signs whereby the safety of British railways may be gauged is the comparative rarity of the occasions on which the Ministry of Transport finds it desirable to inquire into the cause of a railway accident. The reporting to a Government department of accidents on railways was ordered in 1840, but covered only accidents attended by personal injury. By the further

Act of 1842 reports were also required of all serious accidents, whether attended by injury or not. Neither Act, however, provided for inquiries into accidents, but, nevertheless, they were held; nor was any provision made for the publication of the report which the inspecting officer made after his inquiry. The Act of 1871 made good both those omissions. In addition, the range of accident to be reported was very much widened; inquiries were formally legalised; the inspecting officers making an inquiry into a railway accident were required to submit a report to the Board of Trade—the then Government authority—"stating the cause of the accident and all the circumstances attending the same, and any observations thereon or on the evidence or on any matters arising out of the investigations which they think right to make to the Board of Trade," and the Board of Trade was to cause any such report to be made public in such manner as it thought expedient. The prompt publication of accident reports was one of the points made by the inspecting officers before a departmental committee in 1870. It was said that if the reports were at once published "public opinion will so act on the companies that we shall get all that is required." Captain Tyler's anticipations proved to be correct; many railway chairmen protested at the shareholders' meetings at such interference with their administration, but when the Act of 1889 was passed compelling the use of the block system and the interlocking of points and signals, only some of the minor lines and branches—about 15 per cent. of the whole—remained to be done. The procedure as to the publication of the reports remains to-day practically the same as that set up after the passage of the Act of 1871. Copies of each report are sent first to the railway company concerned and, after an interval of about forty-eight hours, to all the other companies, for their information and guidance, and to the Press. By the last-named means the public learns the conclusions of the inspecting officer. The public cannot, however, obtain copies of any report until it appears in a quarterly return. Up to the establishment of the Ministry of Transport in 1919, these quarterly returns were first "presented to Parliament" and then issued as Command Papers. They now appear as Stationery Office publications, and the only document now submitted to Parliament is the annual accident report of the Chief Inspecting Officer. That report for 1934 shows that during the eleven years 1924–1934 inclusive it was considered necessary to inquire into an average of only seventeen train accidents a year; for the eighteen years 1891–1908 inclusive—the period immediately following the Act of 1889—the average was, we find, forty-five a year.

Our remarks hereon are prompted by the issue, as a Stationery Office publication, price 5s., of the reports for the quarter ended March 31st last. The reports are six in number, and as they include those on the three passenger train derailments summarised in our issue of July 5th last, in addition to that on the King's Langley collision of March 13th, they make very interesting reading. As will be obvious, only those accidents—except, usually, those to passenger trains that lead to loss of life—which appear to suggest a lack of supervision, inefficient methods of working or the need for modern equipment, are inquired into. It thus necessarily follows that usually there is found some ground for criticism, but how small is that ground may be seen in the fact that in 1934 there were, according to Colonel Mount's annual report, for that year, eight-one collisions in which passenger trains were involved, but only ten of them were held to call for inquiry. Moreover, not in all cases was criticism offered; or, to put the result more correctly, not in all cases was a recommendation made. These reports, at times, do the companies a good turn. They often reveal some commendable action of a railway servant. The King's Langley report, for instance, records that driver Buckley, of the milk train that ran into the meat train, at once sent his fireman forward to protect the down fast line on which he knew that the express from Euston to Aberdeen was due, and that his last words were "I will get off and try to stop the coal train" which they had just passed on the up slow line. In that attempt he was killed. The report by Colonel Trench, to be found in the present quarterly return, on a motor vehicle being struck by a passenger train at a public road level crossing, will benefit all the companies, in that that officer said that whilst the gate equipment was not on modern lines, he hardly felt justified in recommending, as a matter of urgent importance, the provision of up-to-date equipment, possibly to the prejudice of other crossings where it might be more urgently required. Incidentally, that advice was characteristic of the consideration often shown by the inspecting officers to the merits of each individual case. The same report also referred to the rarity of accidents at public road level crossings as "a tribute to the competence and vigilance of crossing keepers in general." The King's Langley report, as another example of favourable comment, reveals that the 31 miles of the L.M.S. main line between Willesden and Cheddington have recently been equipped with the latest form of block instruments, a considerable amount of track circuit, and with illuminated diagrams. On the other hand, one of the three reports as to the passenger train derailments showed that the district permanent way inspector, although he had had a certain branch under his charge for five years, and although the instructions to men of his rank were that they were to ride, on the footplate, over the lines in their districts once a fortnight or as necessary, he had only twice been over the branch in question on an engine. The second of these three accident reports also referred to the question of engine riding by permanent way inspectors, and recommended that the instructions thereon should be more definite and order the men to make a regular practice of thus travelling over branch lines as well as over main lines. The same report also observed that, under the L.M.S. progressive policy of scrapping older types of engine, the building of new, heavier, and speedier units was making rapid strides. Colonel Mount therefore suggested that the whole question of the classification of branch lines, not only in respect of bridge loading, but of track fitness for speed in relation to types of engine, required review, and that at the same time closer *liaison* between the departments concerned should be maintained so that speed maxima might be regulated in accordance with the authority of the responsible engineer. All such opinions as these, including the favourable comments as well as the critical, are carefully considered by all the companies, and, in some cases, have led to the report forming the basis for a circular to the operating staff which, without mentioning names or other means of identification, recited the facts and the lessons to be learned therefrom.

The report on the Welwyn Garden City collision, as it happened on June 15th, is not included among the six reports mentioned above, but it will be appropriate, as we are discussing railway accidents, if we refer to it editorially and as supplementary to the summary we gave in our issue of September 27th. The Welwyn disaster was the worst, as regards fatalities, since that at Charfield on October 13th, 1928. The next worst accident, again measured by casualties, was that, less than nine months earlier, at Winwick Junction on September 28th of last year. In the King's Langley mishap of March 13th no passenger trains were involved. Previously to all these there was, on January 1st, 1934, a collision between two electrically operated passenger trains at Camden, but without serious personal injuries. All these four accidents arose from the same cause—the clearance of a block signal before the train had arrived—and Colonel Mount's annual report said: "Track circuit would have prevented the accidents at Camden and Winwick Junction," adding, significantly, "and has since been installed." In his report on the other two accidents—King's Langley and Welwyn—Colonel Mount made a remark to the same effect except that the track circuits there would have had to be continuous, *i.e.*, from signal-box to signal-box, remarking, however, as regards King's Langley, that so complete an installation would not be justified. We would, however, commend to the companies a consideration of the question whether continuous track circuit should not gradually be undertaken. It is in use, as an essential feature, in all installations of automatic signalling, and thus is to be found between York and Northallerton, on the L.N.E.R., and between Coulsdon and Brighton and Hove, on the Southern. The L.M.S. has installed it on the electrically operated lines between Camden and Watford, and Bow Road and Upminster, and for its many installations of what is known as advance section signalling. It would be useful to safeguard the rear portions of freight trains that get separated owing to failures of couplings whilst running—of which there were 1461 instances in 1934. Furthermore, it would detect many cases of broken rails, would have already provided the most costly feature in any future automatic signalling, and would be useful in the event of the universal adoption of automatic train control, or, alternatively, cab signalling.

Literature.

The Correct Economy for the Machine Age. By A. G. McGregor, M.A.S.M.E. London: Sir Isaac Pitman and Sons, Ltd. 1935. Price 7s. 6d. Second edition.

The fact that a second edition of Mr. McGregor's book was called for within five months of the appearance of the first is evidence, if such be needed, of the wide interest in economic problems that was aroused by the effect of the industrial depression on thinking people. We shall be surprised if a third is soon needed. In this country the slump is passing; professional men are finding more occupation; the heavy load of unemployment is decreasing, and the position of the distributing trades may be described, at least as good. Schemes for reorganising the economic system will not be listened to when distress ceases. No man sends for a physician when he is well; none runs the risk of a dangerous surgical operation when he feels his health improving. Whatever the rest of Europe may do, we anticipate that Great Britain will abide by the system on which her position was built up, and will only admit those slow changes which penetrate almost imperceptibly into economic systems in harmony with other changes. Neither do we expect to see the United States embarking at present upon another industrial experiment. The lesson of the Blue Eagle will not be soon forgotten. To what extremes the distress in other countries may lead, no one can say, but as far as economic revolutions, like those proposed by Major Douglas and our present author are concerned, we suspect that they will watch the fate of the Alberta experiment rather than make their own.

Mr. McGregor's book is conveniently divisible into two parts. The first is the Introduction; the second occupies the rest of the volume. In the first he expounds, with clearness, the principle of his plan; in the second he develops it in detail. If someone comes to you with a proposal for setting your house on fire, and if you are absolutely opposed to doing any such thing, whatever the specious advantages that may be set forth, it is fruitless to listen to a detailed explanation of how the arson may be carried out with safety and despatch. It will be enough, therefore, if we present Mr. McGregor's principles—or, more strictly, principle, for, in fact, there is but one. If any reader is attracted by it and regards it as a practicable economic change, nothing will suit him but a careful study of the major-portion of the book.

Mr. McGregor's "simple requirement for bringing prosperity is—*Raise All Wages and Salaries by Government Decree!*" The capitals, the italics, and the exclamation mark are the author's. We subscribe heartily to the last. To anyone who has followed Henry Fordian economics, we need say no more. All it comes to is that if you give people more money to spend, prosperity must follow as night the day. The American example does not lead to the conclusion that the principle is sound. Indeed, it gives us cause to suspect that there is a mistake somewhere. We do not recall if Mr. McGregor says it, but certainly others have, that the American mistake in the emergency was lowering wages instead of raising them. Quite logically, they contend that when the sale of motor cars began to fall Henry Ford should have doubled wages, so that more men could purchase his products. Unfortunately, events—economic truths perhaps—were too much for the principle, and willy-nilly Mr. Ford had to reduce wages. Argue about it how they may, that is a hard nut to crack for all those who believe that all industrial ills can be removed by the unrestrained handling of money.

We need scarcely say that Mr. McGregor is not blind to the difficulties and dangers of his scheme, and in his introduction he outlines for later development the safeguards that he believes would be sufficient to prevent a collapse of the system. With some of his arguments we find ourselves in agreement. Our sympathies are with his plea for the individual, for the reduction of restraints on open trade, and for the universal removal of all tariffs, quotas, *et hoc genus omnes*. But we are convinced that parliamentary interference with wage rates is undesirable, if not

disastrous, and that for the State to order every employer of every kind to raise wages and salaries would not effect the end in view, and would be a gross interference with the liberties and rights of the subject.

Origins and Development of Applied Chemistry. By J. R. Partington. London: Longmans, Green and Co., Ltd., 1935. Price 45s.

This is a very remarkable book, the author's diligence is praiseworthy in the highest degree, and his knowledge is quite exceptional. The attempt to trace back the beginnings of a science beyond its recognition as such soon leads to the study of the general achievement of man or to the inspection of the results of the archæologist through chemical spectacles.

Professor Partington gives a wonderful and systematic account of the sources, production, and uses of materials in Egypt, Babylonia and Assyria, the Ægean, Asia Minor, Persia, Syria and Palestine, from the earliest times to the end of the Bronze Age. The study has made it clear that these older cultures provided the knowledge of the use of materials for the later classical period from which historians usually start, and that this classical knowledge was even decadent in some instances of craftsmanship. The materials are dealt with under these geographical headings, each territory being treated as one unit, the plan being to present first a general introduction, then a description of the metals subdivided as precious and useful, and thirdly, the non-metals classified as (1) stone, ceramics, and glass; (2) salt, natron, &c.; (3) organic materials, including medicine.

The references to the literature are amazingly full, and each has actually been seen by the author in the form quoted. There are 7000 numbered footnote references, covering more than 25,000 individual references. Equally remarkable are the indices prepared from 5000 cards by Mrs. Partington; they occupy sixty-five pages in three columns and comprise an index of authors and publications, of persons and nations, of plans, and of subjects.

Enough has been said to indicate the magnitude of the work; it is attractive to illustrate its thoroughness by taking such metals as iron and copper as being of greatest interest to the engineer and find how much is known of them.

Copper is one of the earliest metals known, and that most frequently used in antiquity. It was common in Egypt, but appears to have been scarce in the adjoining countries. The existence of an ancient African copper industry is not established, though in future Africa seems destined to take the key position in the supply of this metal.

Bronze has been considered to be a Phœnician discovery; it was used in Syria as early as 2500 B.C. and appears to have been exported to Egypt.

Iron was in very early use in Egypt, imported from Asia Minor. Specimens of the metal are rare archæological finds, however. The word "mesenu," used for blacksmith, is accompanied by the definite sign meaning "work requiring much energy"; there are others, however, who interpret "mesenu" as meaning hippopotamus hunters! In Palestine the blacksmith was traditionally called user of bellows or user of charcoal. In Babylonia iron was rare and expensive and used for rings, bracelets, and personal ornaments. It first became more plentiful about 1400 B.C. The early Persians probably used iron and steel. In Syria and Palestine, iron ore is plentiful, and the Lebanon iron mines were worked from the tenth century B.C.

In those early days there was no chemistry and little manufacturing industry; humble craftsmen, often highly skilled, wrought with such tools and materials as were available; their work was a labour of love and pride.

It is clear that Professor Partington has provided a store house of information—accurate and verified—for those interested in the beginnings of things, who will, on numerous occasions, return him their profound thanks.

SHORT NOTICES.

Rubber: Physical and Chemical Properties. Croydon: The Research Association of British Rubber Manufacturers, 105–7, Lansdowne-road. Price 45s. net.—This volume is the result of a joint effort on the part of the Rubber Growers' Association and the Research Association of British Rubber Manufacturers to extend the knowledge of the uses of rubber for industrial purposes. By means of the subject index built up by the Research Association of British Rubber Manufacturers, which contains some 300,000 references, the published information on rubber has been thoroughly surveyed in collecting and extracting tables for the book. Most of the data it gives are modern, dating from 1920, but none of the more important classical researches has been neglected. The tabulated data in the book are given under the principal headings of latex, coagulum, raw rubber, soft vulcanised rubber, sponge and cellular rubber, and hard rubber (ebonite). Each of these subjects is treated, in general, under the subdivisions of chemical and physical properties, the latter including mechanical, thermal, electrical, and optical data, behaviour as a solvent in some cases, and towards solvents and gases in others. Where the data allow, the arrangement of the tables for a given single property is discussed as affected by external conditions, composition of the material, and ageing of the material. Hitherto the rubber industry has depended largely upon periodical literature for its widely scattered quantitative data, and the fact that this new volume contains particulars from over 1400 papers, pamphlets and books, extracted and collated by experts, will undoubtedly make it the standard reference work of the industry.

Electrical Measurements in Principle and Practice. By H. Cobden Turner and E. H. W. Banner. London: Chapman and Hall, Ltd. Price 15s.—Primarily written for engineers and others who are concerned with the application of electrical measuring devices to specific purposes rather than for those who desire to familiarise themselves with the more theoretical side of the subject and the mathematical treatment it involves, this book should appeal to many practical men. It presents in a reasonably elementary manner a general account of the types of measurement and the measuring instruments with which engineers are likely to be concerned, and although it presents little or nothing that is unfamiliar to the specialist, many associated with the generation, distribution, and use of electricity should find it useful. The authors deal in detail with the common measurements of current, voltage, power, and resistance, as well as with the application of electrical devices to the measurement of speed, temperature, illumination, &c., and to numerous miscellaneous measurements. Attention is also paid to the more specialised types of measurements, involving the use of D.C. and A.C. potentiometers, A.C. bridges, thermionic valves, and the oscillograph. Short notes on the measurement of the elementary physical quantities of length, mass, and time are appended. Electrical units are fully described, and lists of symbols and abbreviations for units and sub-units are given. Considerable space is devoted to descriptions of instruments used in connection with the wide range of measurements which the book covers.

National Public Works. Volume 2. London: Allen and Unwin, Ltd., 40, Museum-street, W.C.1. Price 8s. net.—The first of these volumes was published earlier in the year and, as stated in our issue of March 29th, contained the replies of twenty-nine Governments to questionnaires which had been submitted to them by the Communications and Transit Organisation with the approval of the Council of the League of Nations. The second volume contains the replies of the nine following countries:—Chile, China, Egypt, Ethiopia, Hungary, India, Irish Free State, Poland, and Sweden. Supplementary information is furnished by certain Governments whose reports also appeared in the first volume. These are Australia, Denmark, France and the Union of South Africa. The two volumes, taken together, furnish an important collection of information on the public works which are in course of execution or in preparation in thirty-eight countries.

Practical Electric Cable Jointing. By W. Maskey. London: Technical Press, Ltd. 1935. Price 5s.—The importance of good cable jointing in the electricity supply industry would be difficult to over-estimate, and although practical experience is the most essential requirement, the author of this book throws much light on the correct methods of carrying out this work and the materials, tools, and equipment the cable joiner employs. The book contains many useful drawings and is written on thoroughly practical lines. It is essentially a workmen's handbook and the information it contains is apparently based on wide experience.

BOOKS RECEIVED.

How Wireless Came. By J. Langdon-Davis. London: Geo. Routledge and Sons, Ltd., 68, Carter-lane, E.C.4. Price 6s. net.

Diesel Engines. By J. W. Anderson. London: McGraw Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 30s net.

Finishing Metal Products. By H. R. Simonds. London: McGraw Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 21s. net.

National Physical Laboratory Collected Researches. Vol. 25, 1935, Metallurgy. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price £1 5s. net.

Mechanical and Electrical Equipment of Buildings. By C. Merrick Gay and C. De Van Fawcett. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 25s. net.

Heating and Air Conditioning. Fourth edition. By J. R. Allen and J. H. Walker. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 24s. net.

River Work: Constructional Details. By H. C. H. Shenton, F.S.E., and F. E. H. Shenton, M.S.E. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 12s. 6d. net.

International Index to Aeronautical Technical Reports. Prepared by the Society of British Aircraft Constructors London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 5s. net.

Mercury Arc Rectifier Practice. By F. C. Orchard. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 15s. net.

Physical Principles and Applications of Magneto-chemistry. By S. S. Bhatnaga, M.Sc., and K. N. Mathur, M.Sc. London: Macmillan and Co., Ltd., St. Martin's-street, W.C. Price 21s. net.

Journal of the British Wood Preserving Society: Vol. V. Edited by A. H. Lloyd, M.C., and R. C. B. Gardner. London: The British Wood Preserving Society, 48, Dover-street, W.1. Price 7s. 6d. net.

La Traction Electrique et le Chemin de Fer: Volume I, Cinématique et Dynamique de l'Exploitation des Chemins de Fer. By H. Parodi and A. Tétrel. Paris: Dunod, 92, Rue Bonaparte, 6e. Price 148f. net.

Home Market Analysis No. 9 of Vehicles in Use and New Vehicles Registered in the United Kingdom During the Years Ended September 30th, 1932, 1933, and 1934. London: Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. Price 10s. net.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

INDUSTRIAL COMPETITION WITH THE FAR EAST.

Sir,—The existing economic crisis on the life of Western Europe, leading, as it does, to such political developments as the Abyssinia situation, is an aftermath of the last war, and accordingly the most powerful warning against war in the future. But it is not the only crisis which the future holds in store for us.

Not war conditions, but economic development in years of comparative and at least official peace are converting the Far East into a manufacturing centre already dangerous to the structure of that part of European economy which is more or less stable at the moment.

What are we to do about competition, from within the Empire's own boundaries, when it is based upon standards of wages and living conditions which, though they may satisfy the Eastern worker, are impossible for the British worker to sustain?

India, Malaya, Hong Kong, all these are areas to which capital is now attracted for the upbuilding of modern factories, capable of opening out intense cut-throat competition against established British industries. In the rubber products trade it is already evident that the Oriental worker and the Eastern factory have come to stay. It may well be that in the course of years a more sophisticated type of worker will become vocal in the East, and demand comforts which are now unheard of luxuries to him, though minimum daily "necessities" to his fellow-worker in the West. Then his wages will go up, no doubt, and it will no longer be possible to exploit his simplicity to the detriment of the British worker.

But meanwhile the danger exists, and grows daily in seriousness. Where is the statesman with a policy which will save our markets from extinction while we are waiting for the Oriental worker to awake to the consciousness that better wages are waiting for him as soon as he makes up his mind to ask for them?

T. F. Howard, M.P. for South Islington.

London, October 14th.

FAST TRAINS.

Sir,—Mr. W. B. Thompson may be quite correct in what he says about the "Hardwicke" engine and its run on August 22nd 1895 from Crewe to Carlisle but he is, I think, a little unfair to the railways of to-day in suggesting, as he does in the concluding paragraph of his letter to you in the current issue, that each company runs its special trains only to places at which it has a monopoly of the traffic. Edinburgh, he says, should have a "Silver Jubilee" train and Birmingham a "Bristolian." Actually Birmingham has the equivalent of the "Bristolian." Since September 30th the L.M.S. 6.20 p.m. train from Birmingham to London has been booked to cover the distance in the even two hours. On the inaugural run the engine No. 5552 "Silver Jubilee" hauling a load of 265 tons covered the 65·1 miles in 59½ min., or at an average speed of just on 66 m.p.h. Between Welton and Hemel Hempstead the train sustained an average speed of 74 m.p.h. for over 50 miles and at one point reached a maximum of 82 m.p.h.

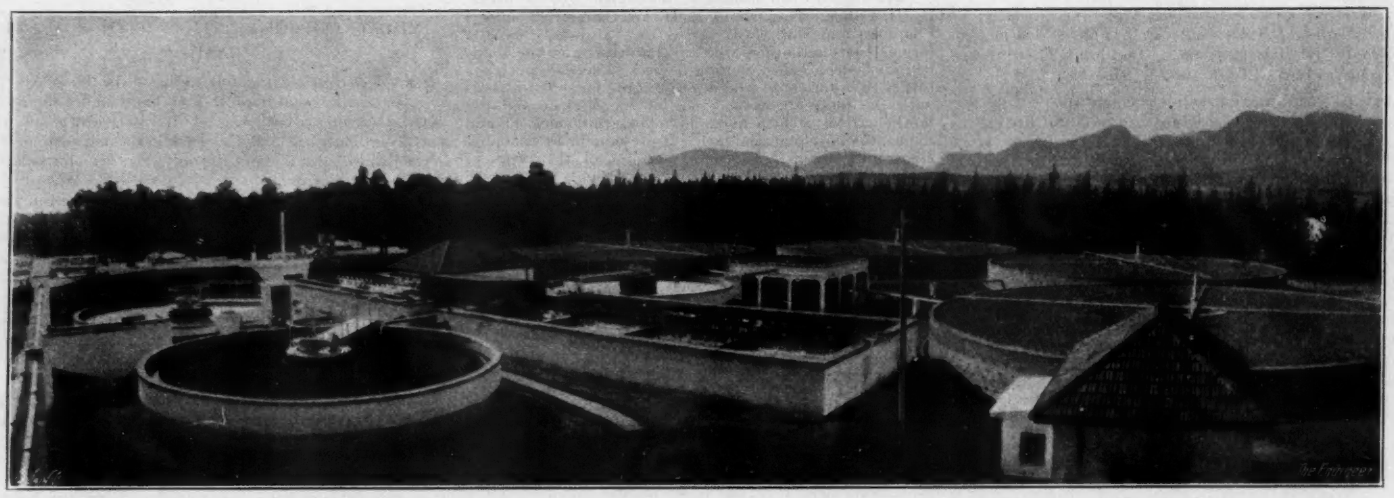
Mr. Thompson, I would also like to note, appears to be under a misapprehension regarding the weight of the L.N.E.R. "Silver Jubilee" train. On the demonstration run on September 27th the tare weight of the train was 220 tons net and 230 tons gross. You gave these figures correctly in your issue of October 4th. The figure of 205 tons to which Mr. Thompson refers appears in the general description of the train published in your issue of September 27th and does not refer to the weight of the coaches as made up for the demonstration run. It is, presumably, the net weight of the coaches without water and other supplies.

Glascolian.

October 14th.

It is announced that the Third World Power Conference will be held in Washington, U.S.A., from September 7th to 12th, 1936. Invitations were issued on September 26th, 1935, by the United States Foreign Office, on behalf of President Roosevelt, and the International Executive Council of the World Power Conference had already decided unanimously to accept such formal invitations when issued. This will be the third plenary meeting of the World Power Conference, the first having taken place at Wembley in 1924, and the second at Berlin in 1930. There have, in addition, been a number of sectional meetings. The Chemical Engineering Congress of the World Power Conference, to be held in London in June next, ranks as one of these series of sectional meetings. The general subject to be discussed at the Third World Power Conference is the National Power Economy. Among the aspects to be treated are the following:—Physical and Statistical Bases; Technical, Economic, and Social Trends; Organisation of Fuel Industries and of Gas and Electric Utilities; Public Regulations; National and Regional Planning; Conservation of Fuel and Water Resources; Rationalisation of Distribution; National Power and Fuel Pol cies. The Second Congress of the International Commission on Large Dams of the World Power Conference will be held in Washington at the same time. Further particulars regarding the plenary meeting of the World Power Conference and the Second International Congress on Large Dams will be issued in due course. British participation will be organised by British National Committee of the World Power Conference, 36, Kingsway, London, W.C.2.

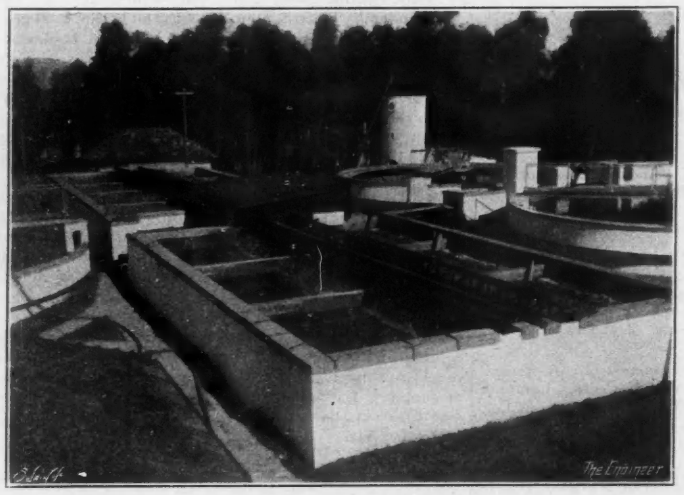
PAARL SEWAGE DISPOSAL WORKS, SOUTH AFRICA



A South African Sewage Disposal Scheme.

THE town of Paarl, situated on the banks of the Berg River, 36 miles north of Cape Town, on the main road to Johannesburg, has recently opened a sewerage and sewage disposal scheme which has a number of features new to South Africa, and the description given below and furnished by the Town Engineer, Mr. H. L. Reitz, Dipl. C.E. Delft (Holland), may be of interest to readers. Paarl is being converted from an agricultural township into a residential town, and manufacturers are taking advantage of the low rates, economical labour, abundance of pure water, and cheap electricity. As the natural drainage of the town is towards the Berg River, the Town Council became perturbed at the increasing pollution of one of its finest assets, and in January, 1933, Mr. Reitz was instructed to proceed with plans for an up-to-date sewage scheme as soon as possible.

This scheme, officially opened at the beginning of June last, was estimated to cost £141,382. The purification works were completed by May last, and about two-thirds of the town has already been provided with sewers. Expenditure to date shows that the whole scheme will be completed for about 10 per cent. less than the estimated costs.



AERATION PLANT IN ACTION

Some features which are new to South Africa are as follows :—

(1) All sewers throughout the whole scheme are of cast iron with lead-caulked joints.

(2) Apart from the various stages of sedimentation the purification treatment provides for mechanical aeration combined with compressed air blown in from underneath—re-aeration of returned sludge—filtration, and also for sterilisation by chlorine gas.

(3) Provision has been made for a double system of main sewers throughout the whole 7 miles length of the town, so that all the factories can be served by an entirely separate system.

Other features are that all factory wastes are separately treated and disposed of at the purification works, and that the modern sludge digesters, apart from providing gas for the automatic heating equipment, boiler and laboratory, also provide an odourless, easily dried, sludge with a nitrogen content valuable to a farming community. All the primary—activated sludge—factory wastes and humus sedimentation tanks are mechanically desludged and automatically controlled and protected.

Briefly, the course of treatment is as follows :—

The sewage scheme is entirely of the separate type, no rain or storm water being allowed access to the system. The Berg River has a fall of 40ft. through the length of the town, and the main sewers follow the river banks.

The domestic sewage—see sketch plan—amounting to about 750,000 gallons per day, flows by gravity through 15in. cast iron sewers to an automatically controlled sewage pump station situated on the west side of the Berg River at the purification works. From there it crosses the river *viâ* a suspension bridge, and is passed through a bar screen on which larger objects are intercepted. It then passes through a detritus chamber which removes the coarser grit. Flowing onward the sewage passes through two round Dorr primary clarifiers (with a retention period of four hours) which remove the settleable solids.

The effluent from these clarifiers flows *viâ* a flume recorder which measures the quantity of sewage undergoing treatment to the aeration chambers. As the effluent flows towards the aeration chambers it is mixed with reactivated returned sludge. The system adopted for aeration is described later.

The effluent from the aerators flows to a round Dorr activated sludge clarifier (with a retention period of two hours) before it is passed on to the dosing chamber. It is the settled activated sludge from this clarifier which is re-aerated and returned to the incoming sewage in correct proportions in order to intensify the subsequent aeration of the incoming sewage.

From the dosing chamber the effluent is periodically discharged by means of an automatic dosing syphon to the feed pipes of the four 90ft. diameter stone percolating filter beds. The effluent from the filter beds is collected in the usual way by means of a floor of porous tiles and channels and passed into another round Dorr clarifier (with a two hours' retention period), where the last impurities are allowed to settle out before it is again passed on. From this last clarifier, or humus clarifier, the effluent flows through a small chlorination chamber wherein it is sterilised to any desired degree before it finally leaves the works. The Council has ample land available to use all of the effluent for irrigation purposes, so that it will not be necessary to pass any of it to the Berg River.

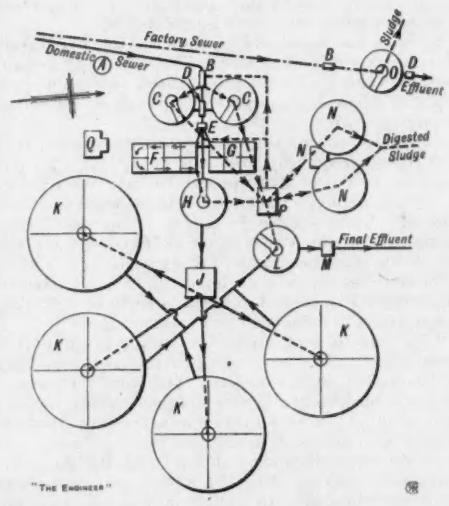
The sludge from the various sedimentation units is dealt with by a battery of four Dorr sludge pumps, which deliver it to the digesters and also carry out various other functions in connection with the handling and mixing of the different kinds of sludge. The digested sludge is dried on specially prepared underdrained drying beds. The present works can deal with the sewage of a population of 30,000.

The scheme was carried out wholly departmentally without the assistance of consulting engineers or contractors, which accounts for the low construction cost.

The factory wastes, amounting to 300,000 gallons per day, also pass through a screen and detritor, and are then passed through a similar round Dorr clarifier with a retention period of five hours. The effluent is then simply discharged into 4 acres of porous ground, which has been cut up into ten plots, each of which is used in rotation for a week. There is practically no silt deposit on these plots, and a similar system employed there during the last five years has given no trouble.

The sludge from this factory clarifier is easily dried in about four weeks. Drying takes place, in rotation, on eight specially constructed underdrained sand beds. The dried sludge is raked into heaps and burnt, leaving a white ash of negligible volume. Future experiments may prove this sludge to have some useful value, but for the present it is simply destroyed.

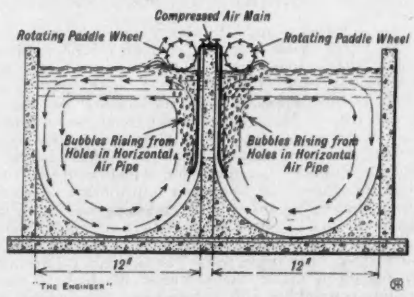
The aeration and re-aeration of the domestic sewage and activated sludge is carried out by means of mechanical surface aeration combined with compressed air from below. The surface aeration is effected by rotating blades



A.—Water tower.
B.—Screen and detritor.
C.—Primary clarifiers.
D.—Sewage recorder.
E.—Division chamber.
F.—Aeration tank.
G.—Re-aeration tank.
H.—Secondary clarifier.
J.—Dosing chamber.
K.—Filter beds.
L.—Humus tank.
M.—Chlorinator.
N.—Digestors and boiler-house.
O.—Factory clarifier.
P.—Sludge pump-house.
Q.—Laboratory.

PLAN OF THE WORKS

fixed to a horizontal shaft as shown by the sketch. It is a modernised method of Dr. Kessener's well-known Holland brush aerators. The blades are 3in. wide, dip about ½in. into the sewage, and are fixed to a light framework drum, 2ft. in diameter, which revolves at 50 r.p.m. The horse-power required is 0·17 per yard of drum length, and amounts to 10 to 12 for the whole plant, depending on wind and the variations in flow of the sewage. In addition the sewage is aerated from below—see sketch—



SECTION THROUGH AERATION TANKS

by means of a horizontal pipe line drilled with very small holes. The air used for the whole plant is 10 cubic feet per minute, supplied at a pressure of 5½ lb. per square inch by a 1 h.p. rotary compressor. This works out at 0·17 cubic feet of air per minute per yard length of tank.

This method was adopted chiefly on account of the low running costs. It has proved itself to be a perfect success. The sewage is aerated for four hours, whilst the returned activated sludge, in the form of a 25 per cent. concentration by volume, is mixed with about 3 parts of

SIR JOHN A. F. ASPINALL, D. Eng.

DRAWN FOR THE ENGINEER BY ELLIOTT & FRY

clarified sewage and re-aerated for fourteen hours before being sent to the aeration tanks to meet the incoming sewage. After, the incoming sewage, together with this re-aerated activated sludge, settles out in thirty minutes in large, healthy, light brown flocs, leaving a clear supernatent effluent with a pH value of 7·2. Probably the good results obtained are not only due to the sewage being pure domestic sewage, unadulterated by factory wastes, but also to this aeration method, which cuts out all possibility of any quiescent septic pockets being formed anywhere in the aeration tanks. The purity of the local domestic water supply, which has a pH of 6·8, no doubt also has its good effect on the process.

The main reason for laying a double line of main sewers was because a very large proportion of the factory wastes consists of strong spent wine from six local distilleries. Local experience has shown that spent wine as well as clarified sewage easily soaks away in porous ground when kept separated. The moment the two are mixed, however, a waterproofing of the ground soon takes place, with the result that it is most difficult to dispose of large quantities of such effluent. Furthermore, a very small quantity of spent wine mixed with domestic sewage makes the resulting mixture a most difficult liquid to purify.

Mr. T. P. Francis, author of "Modern Sewage Treatment," late Engineer and Surveyor to the Dagenham Council (England), and City Engineer at Cape Town up to his recent death, said at the official opening ceremony at Paarl: "The Paarl sewage scheme is the best example of its kind I have seen either in Europe or South Africa—it is truly an example to the world."

The "Relator" Speed Checking System.

THE stroboscope in any of its various forms can be used for determining the speed of rotating objects provided the speed of the stroboscope is adjustable over a sufficient range and is known at all points of the range. In general when the rotating object as seen through the stroboscope appears to be stationary its speed will be equal to, or be some multiple or submultiple of, the speed of the stroboscope. Some doubt may at times exist concerning the multiplying factor to be applied to the stroboscope speed in order to deduce the speed of the object under observation. In many cases, however, the speed of the object is known beforehand with sufficient approximation to remove all doubt. If it is wholly unknown the uncertainty which exists can be eliminated by making additional observations with the stroboscope at speeds which are multiples or submultiples of the first-found speed which reduces the object to apparent rest.

To take a simple example let the object under observation be a rotating circular disc on the face of which a chalk mark has been drawn. Let us suppose that when the stroboscope speed is such as to give 20 glimpses per second the chalk mark appears to be stationary. The inference then is that in one-twentieth of a second the disc is making exactly one, two, three, or more complete turns or that its speed is 20, 40, 60 or more revolutions per second. If our knowledge of the conditions is not sufficient to enable us to say with certainty which of these speeds is the true one we may take additional observations with the stroboscope speed raised to 40 glimpses per second. The mark will now appear either to dance from one end to the other of a diameter of the disc or to remain stationary. In the first event the inference is that the speed is 20, 60, 100 or other odd multiple of 20 revolutions per second. In the other event it will be 40, 80, 120, or other even multiple of 20. Additional means of discrimination is provided by trebling the stroboscope speed to 60 glimpses per second. The mark will now appear either to travel round in the same direction as that in which the disc is turning, but at a lesser speed, to travel round in the opposed direction or to remain stationary. In the first event the true speed will be 20, 80, 140 . . ., in the second 40, 100, 160 . . ., and in the third 60, 120, 180 . . . r.p.s. Increased discrimination, if still required, may be obtained by still further increases in the stroboscope speed.

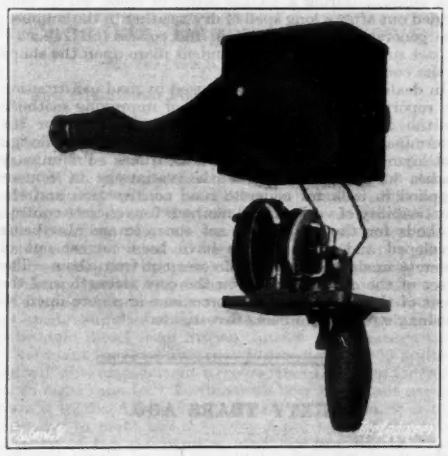
For many practical purposes speed is measured primarily with the object of determining whether machines or parts of equipment are being run at the prescribed rate. For example a line shaft may have an intended speed of 200 r.p.m. It is important from the production standpoint that that speed should be preserved or at least that the speed of the shaft should not fall below that figure. The actual day-to-day numerical evaluation of the shaft speed may therefore involve unnecessary labour since all that is required is a non-numerical check to determine whether the shaft is running fast or slow. The stroboscope clearly lends itself to such determinations provided its driving mechanism is such that it can be relied upon to give great constancy of speed to the stroboscope shutter or equivalent part. If for instance the stroboscope can be set to give exactly 200 glimpses per minute then when the line shaft is running at its correct speed a mark on the face of a disc rotating with it will when seen through the stroboscope appear stationary. If however the shaft is running slow the mark will appear to move round in a direction opposed to that in which the shaft is turning while if the shaft is running fast the mark will appear to turn round in the same direction as the shaft movement.

It is evident that if a check has to be applied to the speeds of several shafts not intended to run at the same rate the stroboscope speed must be adjusted to suit each test. The only relief from such adjustment would be found in the case of shaft speeds which were whole number multiples of a given speed. For example a stroboscope giving 200 glimpses per minute would be applicable to a 200 r.p.m. shaft and, without change of shutter speed, to a 400 r.p.m. shaft. In general workshop speeds do not follow a multiple rule. Hence it is necessary to contemplate the adjustment of the stroboscope speed to suit each case. Such an adjustment is objectionable not only on the score that it involves loss of time and opens an opportunity to the commission of errors but because the provision for making it must almost certainly affect the accuracy of the stroboscope speed. Clearly it will always be easier to devise a mechanism which will run accurately at one given speed than to devise one which will run with uniform accuracy of the same order at any one of a range of speeds.

The practical difficulty here presented has been cleverly overcome by Mr. A. J. Ashdown of Feltham-avenue, East Molesey, Surrey, the inventor of the "Rotoscope" stroboscope which we described in our issue of September 11th 1925 and its improvements subsequently described. Mr. Ashdown's "Relator" system of industrial speed checking involves the use of a stroboscopic device working at a constant speed with high accuracy and consisting of a "gun" which throws a whirling beam of light on to the part the speed of which is to be checked. The standard rate of whirl of the beam is 3000 r.p.m. So far as its action is concerned we may consider the whirling beam as equivalent to a stationary ray which is interrupted 3000 times a minute. At one point of the whirl the object towards which the beam is directed is illuminated by the light. Over the rest of the whirl the light does not fall on the object. The whirling beam therefore effects the same result as an interrupted ray without the mechanical and electrical objections associated with high frequency interruption of illumination.

In order to make a stroboscope of fixed glimpse frequency applicable to shafts or other parts of machinery running at various speeds Mr. Ashdown makes use of numbered collars or similar indicators which are attached to the shafts or parts. Let us suppose that the intended speed of a certain shaft is 200 r.p.m. The collar applicable to this shaft would have the number "15" marked at equally spaced intervals fifteen times round its periphery. In general the number marked on the collar and the number of times it appeared on the collar would be equal to the standard speed of the stroboscope divided by the intended speed of the shaft. As an alternative to the numbers the collars may be provided round their periphery with an equal number of reflectors which catch the light from the stroboscope and return it to the observer's eye.

Since a 200 r.p.m. shaft makes one-fifteenth of a turn in one three-thousandths of a minute it is clear that if



WHIRLING LIGHT GUN

the shaft is running at its intended speed the numbers or reflectors on its appropriate collar will appear stationary when illuminated 3000 times a minute. If it is running slow or fast the numbers will appear to move round against or with the rotation of the shaft. This indication may by itself be sufficient for the purpose of the check. If, however, it is desired to determine by how much the shaft is running slow or fast, it is sufficient to count the rate at which the numbers disappear from view for the apparent rotary speed of the numbers is equal to the discrepancy between the actual and the intended speeds of the shaft.

In the accompanying engraving we illustrate the whirling light gun with its internal parts withdrawn from its casing. At the muzzle there is a small powerful lamp the light from which is focused as a spot on the centre of a concave mirror. This mirror is mounted slightly obliquely on the spindle of a small permanent-magnet electric motor. At the other end of the motor spindle a gear pinion is fixed the teeth of which just touch a slip of hardened steel, or detent, mounted on one leg of a tuning fork of fixed frequency. The battery supplying the motor and lamp is contained in the housing in order to make the instrument independent of all outside connections. The tuning fork is housed inside the handle by which the instrument is held. At the front of this handle a control trigger governing the supply from the battery is mounted. When this trigger is pressed the motor runs rapidly up to speed. As soon as it reaches such a speed that the number of teeth on the pinion rubbing past the detent per second is equal to the frequency of the tuning fork, the fork springs into vibration. Thereafter the detent engages with the teeth after the manner of an escapement with the result that the motor is held to the standard speed determined by the tuning fork. Mr. Ashdown informs us that with a ten-tooth pinion and a "C" tuning fork he has found that the motor speed is held constant at 3000 r.p.m. with an accuracy greater than one in ten thousand. The frequency of a "C" tuning fork is something over 500 vibrations per second—522 on the "new philharmonic" standard. The fitting of a detent to the fork naturally reduces its frequency somewhat.

It may perhaps be objected that the applicability of the system appears to depend upon the speed of the shaft or other part being a whole-number submultiple of 3000. In actual fact many workshop speeds are very closely exact submultiples of 3000. The system however does not break down when such a relationship is absent. To take an example, assume that the intended speed of the shaft is 110 r.p.m. By the rule given the collar required for it should have 27·27 reflectors equally spaced round its periphery. The odd fraction of a reflector is meaningless. If a 27 collar is used as the nearest approximation the error introduced will be very slight. With such a collar a stationary stroboscopic image would imply that the shaft was running at a constant speed of 111·1 r.p.m. or 1 per cent. above the intended speed. For most purposes the checking of the speed to this degree of accuracy would be sufficient.

Progress of Shipbuilding.*

IN the year 1884, I matriculated at Glasgow University as one of the first students of the newly founded John Elder Chair of Naval Architecture and Marine Engineering, so that for over half a century I have been interested in ships and their machinery. It has appeared to me, therefore, that perhaps I could hold your attention sufficiently for a while if I were to draw some comparisons between the state of engineering and of life as conditioned by engineering in those days, and what obtains at present. When I began my apprenticeship both shipbuilding and marine engineering were much simpler than they are to-day. Half a century's effort, discovery, and invention have immensely complicated and enlarged every branch of engineering, and have added many others. The liner of 1884 was a very plain and simple production compared with her modern counterpart. Increases in luxury, comfort, and safety have enormously complicated the hulls of passenger liners and have enlarged dimensions in relation to the numbers of persons carried, while progress in marine engineering has led to the attainment of speeds unthought of in earlier days.

Public rooms of all kinds cater for the comfort and enjoyment of the passengers. Lounges are growing larger and smoke rooms smaller. In a large modern liner there may be lounge, smoke room, reading room, card room, music room, cinema room, theatre, gymnasium, swimming bath, children's room, chapel, grill room, café, verandah, foyer, private dining saloons, dance floor, shooting gallery, courts for tennis and for deck tennis, winter garden or palm court, and shops of various kinds. A daily news-sheet is printed on board. Games of all kinds are catered for and encouraged. No passenger need have an idle moment or suffer from boredom.

All this spaciousness and luxury involves an increased weight of woodwork and of hull fittings and equipment. Yellow pine, that light and easily worked timber, is now practically unobtainable, and has been replaced by the heavier teak and compositions of various kinds laid on by trowel. On the other hand, however, rubber tiles or linoleum are being laid directly on the steel plating of the decks without wood or composition foundation. The "Titanic" disaster of 1912 has led to large increases in the weight of lifeboats and life-saving appliances, while precautions against fire have also added their quota of weight.

Turning to the main structural steelwork of the hull, the members upon which the vessel's strength and stiffness depend, we find great changes. In 1884 the determination of scantlings was entirely in the hands of Lloyd's Register. In 1890 they were joined by the British Corporation—a Glasgow society. Much has been done by the classification societies to simplify and rationalise the main structural members, and to dispose the available weight in accordance with logical and scientific principles rather than by rule of thumb. "Umbria" was a single-bottomed ship 500ft. in length and 40ft. in depth, her length-depth ratio being thus 12·5. In "Campania" this ratio was increased to 14·5. All modern ships have double bottoms; their superstructures have been incorporated in the strength girder, and to-day we have a length-depth ratio of 10·48 in "Normandie," and of only 9·36 in "Empress of Britain." These better proportions obviate excessively heavy scantlings at the strength deck and double bottom.

The "Butterley" beam, with its forged knee deep hold stringers, and web frames, has disappeared, and has been replaced by bulb-angle or channel beams and deep frames. The application of welding, with the resultant weight saving due to the omission of flanges and overlaps, is rapidly gaining favour. Beams, stiffeners, and framing may now consist of angles, T-bars, or bulb plates with their toes welded to the decks, bulkheads, or shell plating. Both the length and the breadth of individual plates have become greater with a consequent reduction in the number of landings and butts. British Standard sections, carefully designed to make the most of their specific weights, are now in universal use, and their properties have all been tabulated for ready reference. The Load Line Committee has laid down a standard of strength for cargo vessels. Many redundant and useless parts have been abandoned, and nothing is now incorporated in the hull structure that is not there strictly on business. Broadly speaking, I think it may be said that in proportion to her size the modern passenger liner has less weight of structure and more of fittings and equipment than her predecessors.

The design of a vessel is, of course, profoundly affected by her means of propulsion. We have seen that there have been many changes in hulls, but these pale into comparative insignificance beside the upheaval that has taken place in marine engineering. In 1884 the compound reciprocating engine was being rapidly displaced by triple-expansion machinery, while the Scotch cylindrical boiler of from 110 lb. to 150 lb. per square inch working pressure held undisputed sway as a steam producer. To-day, we have a bewildering variety of choice both of engines and boilers. We may have triple or quadruple-expansion reciprocating engines, direct drive or geared turbines, internal combustion oil engines, turbo-electric or Diesel-electric drives, and several combinations of these. "Umbria" was a single-screw vessel; twin, triple, and quadruple-screw installations are now common. The paddle-wheel continues to be built and is eminently suitable in many cases for vessels plying in sheltered waters; in the realm of screw propulsion we have aerofoil blades, guide blades, and vanes in great variety, vane-wheels, and the Voith-Schneider system. In the boiler-

* From the presidential address to the Institution of Engineers and Shipbuilders in Scotland, by Professor Percy A. Hillhouse D.Sc., October 8th, 1935.

room steam pressure has risen to 300 lb., 400 lb., and 500 lb. per square inch, and in all large installations the water-tube boiler has entirely displaced the Scotch boiler as the principal steam raiser. The modern marine engineer finds it a matter of no small difficulty to determine in any particular case which of the many types of engine and boiler will be most suitable, and builders are often asked to quote weights, prices, and fuel consumptions for several alternative installations. The use of oil fuel, whether for boilers or internal combustion engines, has had far-reaching effects. Coal has entirely disappeared from naval vessels, and is only used where price considerations turn the balance in its favour.

The aim of the marine engineer has always been to produce more and yet more power on less and less weight and with the minimum of fuel consumption. Great strides have been made. "Umbria," 1884, developed on trial 5·8 i.h.p. per ton of machinery, and consumed about 2½ lb. of coal per i.h.p. per hour. To-day, with geared turbines, water-tube boilers, and oil fuel, we can obtain twice as much power per ton on about one-quarter of the fuel rate. The reciprocating engines and cylindrical boilers of H.M.S. "Commonwealth," built in 1902, produced 10 h.p. per ton; in 1919 the water-tube boilers and turbines of H.M.S. "Hood" developed 150,000 s.h.p. at the rate of 28 h.p. per ton. In destroyer work we can compare "Handy," built in 1895 and giving 42·5, with "Dainty," of 1933, giving 71·5 h.p. per ton. There is a wide gap between the battleship figure of 28 and the liner's 10 or 11. The former performs intermittent service only, while the latter has to carry on week in week out with but little opportunity for recuperation. General de Vito, however, has recently stated that two independent Italian designs for an installation of 200,000 s.h.p. with turbo-electric drive and a pressure of 500 lb. per square inch in small-tube water-tube boilers burning oil fuel both envisaged 26 h.p. per ton with a fuel rate of about ⅔ lb., and he sees no reason why we should not with confidence assume the more moderate figure of 20 s.h.p. per ton of liner machinery. We can now safely assume fuel rates of 0·6 lb. or even less of oil burned under boilers and 0·4 lb. or less of oil consumed in internal combustion engines. These are great advances, and as I have already said, have brought within the bounds of possibility designs and performances which would have been regarded as the dreams of a madman not so very many years ago.

The development of the experimental tank has been a great boon to the naval architect. Though William Froude had established his first tank at Torquay about 1874, his work was confined mainly to warship forms. The private shipbuilder, in his estimates of horse-power, had to rely upon the Admiralty coefficient, and as to form or lines upon his own individual fancy. Shipbuilders were still obsessed by the theory that a ship in motion had to plough a furrow in the water and that the smaller the area of the midship cross section the less would be the power required to dig out this channel. This led to a restriction of beam and a tendency towards instability. There was no definite guidance as to how the value of the Admiralty coefficient would be affected by variations in dimensions or proportions or shape, and the selection of a suitable coefficient was largely a matter of experience, individual judgment and intelligent guesswork—the process has been aptly named "guesstimating." Nowadays, every maritime nation has its experimental tank or tanks, and the lines of nearly every vessel, be she cargo ship, tramp, or liner, are submitted to the scrutiny of an experimental tank staff and she has her model run and her resistance measured in a tank. Propellers are also tested in conjunction with the model hull, and a very accurate prediction of the necessary horse-power can be obtained. For preliminary work reference can be made to a vast amount of published results of series of "methodical" tank experiments, notably those published by Froude in 1904 and Taylor in 1916. The data and curves given in these publications enable the designer to assess correctly the effects upon resistance of dimensions, proportions, and form, and have entirely superseded the Admiralty coefficient as a means of predicting horse-power. Here, again, science has ousted rule of thumb to the immense advantage of the present-day designers.

The Road Research Board Report.

In a Journal note on October 4th, the publication of the first report of the Road Research Board of the Department of Scientific and Industrial Research was announced. The report gives the results obtained by investigations into the various problems of road construction. One part of the report is concerned with skidding. Important vehicle characteristics, however, require investigation, such as ratio of wheel track to wheel base, and the braking of vehicles with trailers and the like. "One obvious method of continuing the research," the report continues, "would be to skid full-sized vehicles on a large surface. This method would be expensive and somewhat dangerous, but may eventually have to be faced. In the meanwhile careful consideration has been given to further work with models, and this necessitates a knowledge of the 'model laws' involved." Various road testing machines are described in the report, with their characteristics. But, as the report points out, the results of the road testing machines will not supersede full-scale tests on roads, but will, it is hoped, form a link in the chain between the laboratory and the road. Although the machines may give artificial intensification of many factors including even weathering conditions, tests with them cannot take into account the "time factor," which may profoundly affect, for example, the wear of bituminous materials, while allowance must also be made for the effects of road foundations. The aim is to establish by machine tests on samples of road sections of known durabilities a "scale" against which the probable performance of new forms of materials and construction can be estimated.

The report describes the methods adopted for determining the value of the forces and the vibrations transmitted to roads by vehicles of various types and the correlation of the results with the type of pavement, subsoil, &c. These forces, apart from those due to atmospheric conditions, represent the major forces the road must be designed to resist. Tests previously carried out by the Ministry of Transport on the Kingston By-pass showed that the type of bituminous carpet laid on concrete had little influence on the magnitude of wheel impact forces, and further, that the results obtained on unsurfaced concrete were not appreciably different. Similar tests, however, on unsurfaced concrete on the Hampton Court-Esher Road produced different results. This result suggested that the type of subsoil under a road might effect the magnitude of the impact forces, and further tests have been carried out to investigate the point. A trailer having a total back axle load of 3 tons was used. It was towed over a standard obstruction at speeds of 3 to 25 m.p.h. After comparative tests it was decided to adopt a plank 1in. thick for the standard obstruction, since it was found to cause a blow comparable to those to which the road would be subjected when its surface became irregular with wear. The records show two impact peaks, the first occurring when the wheel struck the object, the second when it dropped again to the road. The magnitude of the first increased uniformly with speed and at 25 m.p.h. was about 2⅜ tons or 1¾ times the static load. The second peak reached a maximum of 3 to 3⅜ tons (2 to 2½ times the static load) at approximately 20 m.p.h., after which it decreased slowly. Observations with four types of subsoil indicate distinct variations for the "drop" impacts, but little differences as regards the "shock" impacts. "The greatest 'drop' impacts," it is stated, "occurred on the Colnbrook By-pass (gravel) and the Leatherhead By-pass (chalk)." The latter road was laid on solid chalk and it was therefore not unexpected that high impact values should be recorded on it. The tests on the gravel subsoil on the Colnbrook By-pass were made during very cold weather, and the high impact values in this case may be accounted for, in part, by the freezing of the subsoil. The lowest figures were obtained on the North Orbital Road, where the soil contained over 80 per cent. of sand. The impacts recorded in the case of roads on clay subsoils differed to a certain extent on the various sites, and in all cases were found to lie between those for sand and hard chalk. Impact loads were, on the whole, slightly higher for the clay subsoils during a second series of tests, which were carried out after a long spell of dry weather in the summer. The general similarity between the curves for "shock" impact suggests that it is dependent more upon the shape of the composition or subsoil.

In dealing with the processes used in road construction the report stresses the importance of improving methods for the control of concrete during laying and for the determination of the factors which influence the design and laying of road slabs and foundations. Preliminary studies have been made of the variations in cement supplied in bulk for concrete road construction and the practicability of various field methods for concrete control. Methods for the analysis of set concrete are also being developed and examinations have been carried out of concrete in slabs by means of cores cut from them. The effect of the cutting action on the core strength and the effect of the presence of reinforcement in a core upon its crushing strength are being investigated.

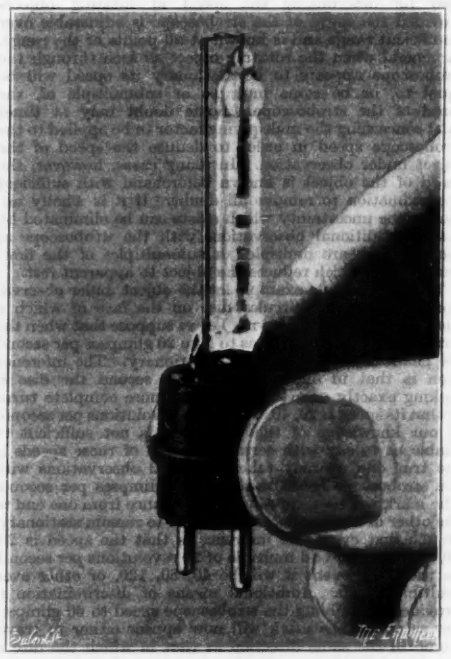
SIXTY YEARS AGO.

An article entitled "Water in Aid of Steam Power," in our issue of October 15th, 1875, presents us with an illustration of the fact that far-sighted vision may be founded on wholly false data. The article as its title suggests was a plea for the development of our water-power resources as a means of supplementing our diminishing coal supplies. In England, we said, water power was naturally scarce and particularly so in the neighbourhood of great manufacturing centres. In Scotland great developments were possible but it was in Ireland that we saw chief opportunity for the establishment of water power plants. From the Shannon we estimated that 14,000 h.p. could be developed. Lough Corrib near Galway should yield 1300 h.p. At Ballyshannon the Lough Erne basin should furnish 1836 h.p. and from the river Bann flowing past Coleraine 1620 h.p. should be obtainable in addition to 1235 h.p. from a second station higher up the river. There were other possible sources of water power but the information which we had concerning them was not sufficient to enable us to evaluate them. Having surveyed the field open for development we proceeded to investigate the financial side. The conclusion which we reached was that power derived from the water resources of Ireland would be available at 50 per cent. of the cost of generating the same power by steam. But what was to be done with the power? For the most part it would be generated at some distance from manufacturing centres. We doubted whether it was reasonable to rely on new factories being attracted to the neighbourhood of the power plants. In the provision of means for transmitting the power to works already established we foresaw the solution of the problem. Reviewing possible means of transmission we considered the use of wire ropes supported on pulleys, the employment of a vacuum as on the atmospheric railway and a development of Armstrong's system of hydraulic transmission. We dismissed these methods in favour of the use of compressed air an idea which, we said, had been proposed by William Mann of Brixton in 1829 for the transmission of power to locomotives and other machinery and which quite recently had been applied with great success in connection with the piercing of the Mont Cenis Tunnel. We did not mention the fact, but were doubtlessly aware of it, that the use of compressed air for the transmission of power on the Mont Cenis works, had already inspired Westinghouse in his invention of the continuous railway brake, a minor example of the transmission of power over a distance. We were cautious in our estimate of the efficiency of generating and transmitting the power from the rivers to neighbouring towns. Taking the Shannon scheme for example we thought that of the 14,000 h.p. believed to be available, 10,000 h.p. might be actually produced at the site, and that using the compressed air system for transmitting it over the 12 miles to Limerick 3000 h.p. might be delivered to the mills of that town. . . . We clearly foresaw the birth of the central power station without foreseeing that which was necessary to make it practicable, the development of means of generating and transmitting electricity on a large scale. We foresaw the Shannon power scheme but greatly underestimated its magnitude. The final development of that scheme covers the provision at a cost of over five million pounds of plant capable of developing 180,000 h.p. and the distribution of the energy over the whole of Southern Ireland.

A New Discharge Lamp.

As the result of extensive investigations carried out in the physics laboratories of Philips Lamps, Ltd., whose London headquarters are at 145, Charing Cross-road, W.C.2, a new super high-pressure mercury vapour lamp, with a brilliancy much in excess of that of ordinary high-pressure lamps of this type, has been produced. It consists of a quartz tube with internal and external diameters of $^{5}/_{64}$in. and ¼in. respectively, the length being determined by the light output required. At each end there is a tungsten wire electrode sealed into the quartz, with an interposed layer of special glass to deal with the difference of the coefficients of expansion of the tungsten and quartz. To facilitate the emission of the electrons necessary for the electrical discharge, the electrode tips are coated with a deposit of alkaline earth oxides, and each tip projects from a small drop of mercury which condenses at each end.

The complete lamp is enclosed in a water jacket to dissipate the heat, as the lamp works at a temperature of from 4000 deg. to 8000 deg. Cent., which also necessitates the use of quartz instead of glass. Quartz is also necessary to withstand the high internal pressure, which is no less than 150 atmospheres. Lamps have been made for working at twice this pressure with a brilliancy twice as intense. While a mercury lamp of the ordinary type rated at 9 kW



NEW DISCHARGE LAMP

with a luminous flux of 500,000 lumens, or about 40,000 candle-power, could not previously be made smaller than about 3ft. long and 3in. in diameter, a new lamp of the same power is 1in. long and ¼in. in diameter.

Normally, these new discharge lamps operate with A.C., and in common with other electric discharge lamps, they require a stabilising device to ensure steady working. This consists of an auto-transformer with a self-induction sufficient to stabilise the discharge, whilst the no-load voltage serves for sticking. The lamp rating is defined by the potential gradient between the electrodes in volts per inch, which does not at present exceed 1250 volts. Under these conditions the lamp consumes about 1500 watts per inch, and the current is approximately 1·35 ampères. The power factor is about 0·9. A notable feature of the lamp is the whiteness of the light it produces. A spectroscope reveals the fact that when analysed the light gives a radiation showing a continuous spectrum upon which the greatly broadened mercury lines stand out. The continuous background extends throughout the entire visible spectrum, including the red rays. As a result of this, there is practically no colour distortion.

The amount of light produced by the lamp for the current it consumes is exceptional, the efficiency being from 50 to 60 lumens per watt. As the light source is less than ⅛in. in diameter, the brightness may attain as much as 260,000 candles per square inch. The total luminous flux and the luminous intensity or candle-power are proportional to the length of the lamp.

A lower rating lamp of this type, but without the water jacket, operates in air. From the spectroscopic point of view, the light is slightly less white than that produced by the water-cooled lamp, but this can easily be corrected by using a reflector painted with "Signalon," a fluorescent red paint. The luminous efficiency is about 40 lumens per watt, and 70 watts are required to operate the lamp, which gives a discharge ⅛in. long. The lamp is intended for general lighting purposes.

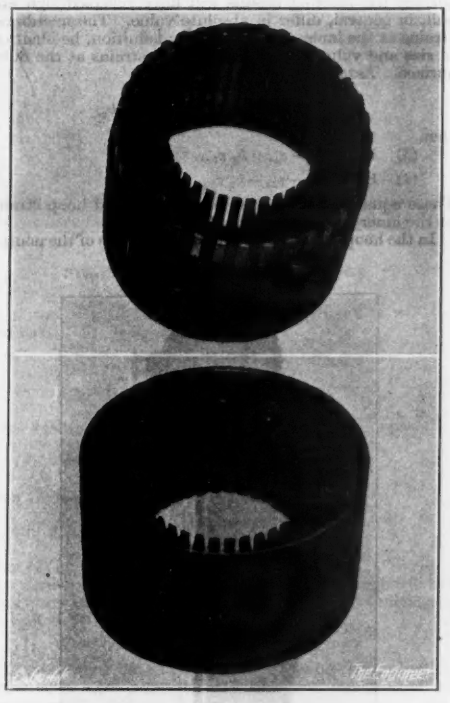
The high brightness of the new lamp makes it highly suitable for use when it is necessary to project light in the form of a concentrated beam, as is essential in cinema and other projectors, lighthouses, &c. The small dimen-

sions of the light source permits a considerable reduction in the size and price of the optical devices employed for projection purposes. Since the lamp absorbs up to 1500 watts per inch length of the discharge, a nearby point light source of high power is obtained. It is anticipated that by the adoption of a suitable synchronising device the lamp will enable the shutters of cinema-projectors to be dispensed with. Owing to the actinic properties of its light and the absence of heat radiation, the lamp is expected to find a field of application in film studios, whilst as a source of violet radiation it should appeal to the medical profession.

A New Motor Stator.

An induction motor stator claimed to reduce iron losses, improve ventilation, and to promote silent operation, has been introduced by the Normand Electrical Company, Ltd., of 3, North Side, Clapham Common, S.W.4. The stator stampings are stacked in a steel pressing resembling a comb bent to form a circle and with the back bent at right angles to the teeth near the roots. The outer shell of the stator is a heavy-gauge rolled steel ring, into which this steel pressing with the stampings loosely stacked in it is pressed under hydraulic pressure. The upper platen of the press used for applying the pressure is formed as a special die, which clinches the projecting ends of the teeth of the comb down on the top stator lamination at the same time as the stack of laminations is forced into the shell.

On removal from the press the laminations are therefore held under great pressure between the steel ring forming



STATOR FOR ELECTRIC MOTOR

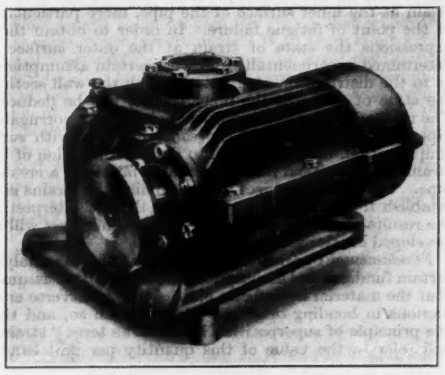
the back of the comb and the ends of the teeth which are spaced at intervals of about ¼in. The gaps between the teeth form passages between the outside of the stampings and the inside of the rolled steel shell, and air is driven through them by the centrifugal fan, a bakelite plate between the fan and winding ensuring correct air distribution. By avoiding the piercing of the laminations for rivets this form of construction makes the entire thickness of metal behind the slots available for carrying the magnetic flux. Local points of high flux density are avoided and it is possible slightly to decrease the diameter of the stampings.

Magnetic short circuits produced by rivets between the outer plates are eliminated, whilst as the stampings are held together by the comb at close intervals instead of at four or six points, "hum" is greatly reduced. The upper illustration shows the stator partly pressed into the shell, whilst the lower picture shows the stator ready for winding. The new stator forms the subject of patent No. 413,771, and it is being adopted in the construction of the Normand Electrical Company's "Neco" A.C. motors.

Vertical Shaft Worm Reducing Gears.

The latest addition to the range of "Radicon" speed-reducing units made by David Brown and Sons (Hudd.), Huddersfield, is the vertical shaft unit shown in the accompanying illustration. The low-speed, worm-driven shaft can extend above or below the unit, which is particularly suitable for stirrer, mixer, agitator, and grinding mill drives. It incorporates all the features of the David Brown "R H U" reducer, such as adequate cooling, improved lubrication, and a centrifugally cast Taurus bronze worm wheel. For drives such as those mentioned, it is important that the unit should be splash and dustproof—the totally enclosed unit illustrated meets these requirements. When the output shaft projects downwards oil leakage is prevented by the use of the maker's patented screw pump, which is an integral part of the gear calling for no attention. When the unit is mounted on a pedestal or other high structure, its compactness tends to overcome site restriction difficulties. The gear can either be mounted independently of the driving motor, or both can be arranged on a cast iron or fabricated bed-plate, according to requirements.

Helical gear units for motor drives are, of course, also made by David Brown, Ltd. They are adaptable to a wide variety of applications and are made for powers up to 2500 h.p. A double-helical wheel and pinion carried



VERTICAL SHAFT WORM DRIVE

in roller bearings to minimise friction losses and preserve the alignment of the gears provide a range of speed ratios between 5 : 1 and 10 : 1 in a single stage of reduction.

Canadian Engineering News.

(By our Canadian Correspondent.)

New Aluminium Plant.

The Aluminium Company of Canada, Ltd., has started construction of a new plant at Arvida, Quebec, which will be ready for operation about March of next year. With its completion another division of the aluminium industry will be established in Canada. The engineering work is well advanced. Contracts for steel and other building materials have been let and orders have been placed for most of the equipment. The new plant will treat bauxite by a chemical process successfully used in other countries, but different from any previously used in Canada. As no bauxite or other ore of aluminium occurs in Canada, supplies of that material for the new plant will be brought direct from British Guiana. The construction of the plant involves an expenditure of 1,000,000 dollars, and will give employment to more than 1300 men for from six to eight months. To illustrate how important export trade is to the Aluminium Company of Canada, it is but necessary to point out that only 6 per cent. of the total capacity of the company is used in Canada. In 1934, although below the peak of 15,144,509 dollars in 1929, exports of aluminium were valued at over 8,000,000 dollars. Exceeded only by nickel and copper, aluminium ranks third among the non-ferrous metals exported from Canada, and plays an important part in maintaining the Dominion's favourable foreign trade balance.

Century of Railroading.

After a century of railway construction, Canada now has over 42,000 miles of railways, and in railway mileage *per capita* is second only to Australia among the nations of the world. The construction of Canada's first railway began in June, 1835. This line, known as the Champlain and St. Lawrence Railway, was only 16 miles long. It connected St. Johns and Laprairie, Quebec, and was in reality a portage railway, the original purpose being to shorten the journey between Montreal and New York. From St. Johns transportation was effected by boat through the Richelieu River to Lake Champlain, and then along the Hudson River. The railway was opened for traffic one year later, and the motive power in the first year of its operation was horses. In the following year, 1837, locomotives were provided. Canada's railway era really began in 1851, with the inauguration of the Grand Trunk System, and several subsidiary lines throughout Ontario and Quebec. At the time of Confederation, 1867, the railway mileage in Canada was 2278. The next and most important step in railway development was the building of the Canadian Pacific Railway, completed in 1885. The completion of this transcontinental line linked the east and west, and made the Dominion for the first time a real, united, economic unit. Rapid settlement in the areas tributary to the first transcontinental railway provided abundant and lucrative traffic, and led to the construction of two more transcontinental lines. With the coming of the war the hopes of the builders of these lines were not realised, and they were eventually acquired by what is known to-day as the Canadian National Railways, which, operating 24,000 miles of line, is the largest system on the American continent.

State of Business.

No decisive change in the condition of business has occurred for fifteen months past. From the standpoint of the country at large, the first half of 1935, like the major part of 1934, was characterised by a notable state of stability. It should not be forgotten, however, that this stability has been the result of conflicting tendencies. On the one hand, some favourable developments have been recorded, and prospects for agriculture have improved. On the other, certain factors continue to cloud the outlook for further expansion. From the industrial view point, the moderate upturn in manufactures, the recent increase in the volume of construction, and continued activity in the mines, provide encouragement. In the manufacturing field, automobile plants have been busy and iron and steel trades as a whole have shown a moderate revival. Construction has been stimulated by the public works programme of the Dominion Government. The primary iron industry has been more active this season than last. Output of pig iron during the six months ended June was 70 per cent. larger than during the same six months of 1934. Lumbering has felt the effects of reduced demand from the United Kingdom, but at the same time has benefited from larger sales in the domestic market and from a slight increase in the exports to the United States.

Railway Equipment.

It is understood that whatever differences existed between the railways and the Federal Government during recent months over the terms of the Government financial guarantee have been adjusted, and that equipment orders are about to be placed. Actually, however, informal arrangements have been made between the railway companies and the equipment builders for commencement of the work, it is learned, and as a result the latter are working on preliminaries, while certain minor adjustments as to type, number of certain classes, &c., are being made by the railways. Meantime, orders for three new steam locomotives have been placed by the Montreal Harbour Commissioners, at a total cost of 105,000 dollars. They will be built by the Montreal Locomotive Works.

St. John Harbour Berths.

The Foundation Company of Canada, Ltd., of Montreal, has been awarded the contract for the reconstruction of berths 1, 2, 3, and 4 in the harbour of St. John, New Brunswick. The work will include the reconstruction of the bulkhead at Sand Point. The contract price is 2,242,540 dollars. The type of construction to be used will combine reinforced concrete cylinders and timber pile clusters, which will support a reinforced concrete slab flooring. A retaining wall will keep in the backfill and serve as a foundation. No. 4 berth will be 450ft. long; Nos. 2 and 3 berths are to be combined into one unit of 909ft. long, and No. 1 berth will be 536ft. long. A 233ft. extension is to be built to No. 14 berth, linking it to No. 1. Although the present contract is only for construction of the berth sub-structures and bulkhead, it is proposed when the sheds are added to have a right-angle shed extending along berths 2 and 3, with a wing continuing along berth 1 and the extension to be built to No. 14. A period of eighteen months will probably be required for the construction of the berths, without the sheds and other facilities.

Tin-plate Rolling Mill.

The Dominion Foundries and Steel Company, Hamilton, Ontario, is planning to spend 50,000 dollars for a new building to house a rolling mill for the rolling of tin-plate. The tin-plate industry, which the Dominion Foundries are inaugurating, will be an added feature to their former industry. The total outlay for the manufacturing plant will be in the neighbourhood of 1,000,000 dollars.

Engineers' German Circle.—There was a good attendance to mark the opening of the fourth session of the Engineers' German Circle on Monday, October 14th. Dr. S. J. Davies took the chair in the Large Hall of the Institution of Mechanical Engineers, and over seventy members and guests were present. A joint paper on "Progress in the Control and Governing of Engines and Air Compressors during the Last Fifty Years" was given by Herr Dipl.-Ing. Proell, of Dresden, and Herr Ober.-Ing. H. M. Meier-Mattern, of Amsterdam. The subject was well illustrated by drawings and lantern slides and the authors dealt with the development of engine governor design and the application of oil-controlled governors and valves for steam engines, locomotives, and oil engines. A good discussion took place. The meeting was followed by an informal dinner at Eliots Club.

"Sternocleanse" and "Sternolease."—We have recently had an opportunity of testing two new preparations which have been placed on the market by Sternol, Ltd., lubricant manufacturers, of Finsbury-square, E.C.2. The first, "Sternocleanse," is a soft, pleasant smelling cream, which is readily absorbed by the skin and which is intended to be applied to the hands before starting dirty or grimy work not involving contact with water. The cream rapidly forms a protecting layer on the skin, filling the pores and preventing the ingress of dirt, oil, paint, tar, &c. After work the protecting layer and all the dirt can readily be removed with soap and warm water. It is claimed that the cream is a safeguard against dermatitis and other troubles which occasionally affect the hands of machine tool operators and others who have to work in contact with oil. We have tested the cream and find it fully efficient and pleasant to use. The second preparation, "Sternolease," is a clear, brown oily liquid, which is intended to be applied to rusted or corroded nuts and bolts to facilitate their removal. It is claimed that it penetrates through rust and destroys corrosion, but lubricates metal parts. In addition to its primary object, we have found that the preparation possesses properties as a cutting compound which seem to deserve investigation, and that it is a good lubricant for french polishing.

The Institute of Fuel.—Over 600 members and guests attended the ninth annual dinner of the Institute of Fuel, which took place on Wednesday, October 9th, at the Connaught Rooms. The chair was taken by the President, Sir John Cadman, and the toast of "Science and Industry" was ably proposed by Sir David Milne Watson. Sir Frank E. Smith responded. Lord Rutherford, who proposed the toast of "The Fuel Industry," said that the Institute had before it a great opportunity, but he was not quite sure that it was using it to the full. In our research work we had fallen behind our competitors in other countries. On the Continent the gas grid was in successful operation, but in our own country only a beginning had been made at Sheffield. Burning coal was a wasteful means of producing energy, and research was needed to improve the efficiency of our fuel processes. In his reply Sir John Cadman pointed out that one of the greatest difficulties was the structure of the fuel industry as a whole. There were, he felt, great possibilities for the coal industry, if competition and individualism disappeared and gave place to greater co-operation and better service for the consumer. The Melchett Medal was then presented to Mr. Harry R. Ricardo, who, the President said, was a pioneer worker in the field of internal combustion engine operation and its relation to fuel. Mr. Ricardo's suggestions for the improvement of fuels and the methods of using them had improved enormously the efficiency of the internal combustion engine, both for road and air transport. After the dinner a dance and cabaret entertainment took place. Mr. P. C. Pope, the Secretary of the Institute, and his staff must be heartily congratulated on the excellent arrangements made.

Power in Steel Works.*

When one considers the mechanical and electrical equipment, together with the foundation and structural work, that is required for a modern iron and steel works, the engineer in this industry probably requires to be much more versatile than in any other. In the solution of his problems he finds that the ordinary methods of calculation are of no use to him whatever. Indeed, one of the sayings in the steel trade is that the engineer uses the usual factor of safety of ten, doubles this, and adds further to this what he thinks to be necessary according to his judgment or experience.

In the production of finished steel as it is understood in the heavy steel trades, 6 to 7 h.p. needs to be installed per ton of steel produced. This includes all power required for the manufacture of coke, pig iron, and the subsequent steel. The aggregate of power required in a steel works for the production of, say, 8000 tons of steel is thus between 50,000 and 60,000 h.p. This may comprise gas engines, the driving of blowers or electric generators of approximately 4000 to 6000 h.p., steam turbines of 2000 to 10,000 h.p., rolling mill engines or motors up to 25,000 or 30,000 h.p., and a steam consumption of possibly 1½ tons per ton of steel produced. Or, stated otherwise, a consumption of approximately 200 to 250 kW per ton of steel rolled.

The boiler plant has to be specially designed to carry over very serious peak loads and, as compared with the more regular industries, may appear to be out of balance in relation to normal requirements. The boiler plant must be capable of responding to differences in rolling due to the quality of the steel being rolled, requiring either higher or lower temperatures in the process. As mentioned earlier, it is only by virtue of long experience that the engineer is able to effect anything like a reasonable compromise, and again the ordinary methods of calculation are of little or no use to him.

The fluctuations mentioned have to be provided for by the engineer, whether the drive is steam or electric. On the steam side the exhaust from the mill engines can be put into low-pressure steam accumulators, and from there to mixed-pressure turbines. Where the electric drive predominates high-pressure steam turbines are used and the position is cared for by using high-pressure accumulators. Considerable thought has to be given in designing the power plant, so that, when fast rolling takes place, there is sufficient volume of steam; then, when rolling ceases, if only for a few minutes, the boiler plant must be checked promptly to avoid blowing large volumes of steam to waste.

In addition, subsidiary plants involving the use of machinery are required, as, for instance, in the production of road-making materials, such as tar macadam, concrete flags and shapes, and even fertilisers. The foregoing gives some idea of engineering work in the manufacture of iron and steel.

Before concluding I am desirous of making a general comment. It is an unfortunate characteristic of the British race that we are so apt to criticise each other and draw the attention of the world to our presumed shortcomings by comparing ourselves with Continental and American manufacturers. I am strongly of the opinion that such comparisons, without real foundation, are frequently listened to and believed by other people, to our detriment. There are in this country, I say emphatically, as good scientific and technical engineers as anywhere in the world. If a country can possess at one and the same time, as does Great Britain from time to time, records for speed on water, in the air, on the railway, and on the roads, also in bridge construction, it must possess some of the finest engineers, manufacturers, and workmen in existence, who have supplied the various materials that have been utilised in our ships, aeroplanes, locomotives, motor cars, and bridges. It would be foolish, however, to claim that we cannot learn anything from our Continental and American friends. Further, I would add that we welcome at all times their assistance and co-operation, but I do seriously deprecate the constant suggestion made in certain directions that the British manufacturer and engineer are not technically the equals of their competitors.

And now, although it may not be quite relevant to this address, I would like to suggest to the engineer in a general way that, although engineers are already known to be a versatile body of men, they should add further to this versatility. Part of their training should be to study the elements of accountancy, and also of commercial law, because in to-day's conditions this knowledge is essential. They should realise that engineers are frequently called on to discuss financial and legal problems as well as those connected with engineering. In saying this I do not for one moment suggest that engineers should attempt to become either expert accountants or competent lawyers. They should also interest themselves in the affairs of local government, in view of the large amount of engineering that enters into everyday life.

In conclusion, all that I ask on behalf of the British engineer, and the steel works engineer in particular, is adequate recognition of his technical and practical skill and devotion to his profession.

A note in the *Chemical Trade Journal* says that rock salt is being successfully used in road construction work in the U.S.A. Tests carried out have been found very satisfactory after subjection to the ordeal of a very heavy rainstorm and floods. The process consists in surfacing the road with a mixture of clay, gravel, and rock salt. The last mentioned not only plays the part of a binder with regard to the clay, producing a kind of cement, but by its crystallisation retards the evaporation of absorbed moisture. The upper layer of the road thus becomes both moist and firm, and the road is non-skidding. Many miles of roads in the United States have already been treated by this process, and the results in every case are claimed as satisfactory. The cheapness of the method is a further advantage.

* From the Presidential Address of Mr. J. A. Thornton to the Manchester Association of Engineers, October 11th, 1935.

Strength and Flexibility of Corrugated Piping.*

By ROBERT L. DENNISON.

No. V.

(*Continued from page 388, October 11th.*)

The Analysis of Strain.

The Purpose of the Analysis.—The results to be sought in this analysis are the expressions defining the state of strain at the inner surface of the pipe, more particularly at the point of fatigue failure. In order to obtain these expressions the state of strain at the outer surface is determined experimentally and with certain assumptions, as to the distribution of strains through the wall section, the state of strain at the inner surface will be deduced. The method is here presented as applying to a corrugated pipe. As will be shown, the same method, with some simplification, may be applied to the determination of the strains in the critical zone of probable failure in a creased pipe. The ultimate object in determining the strains is to establish the state of stress. The method of interpreting the results of the strain analysis in terms of stress will be developed in later sections.[21]

Fundamental Considerations.—In the following analysis certain fundamental assumptions are made. It is assumed that the material is perfectly elastic, that transverse cross sections in bending originally plane remain so, and that the principle of superposition holds. The term "strain" will refer to the value of this quantity per unit length.

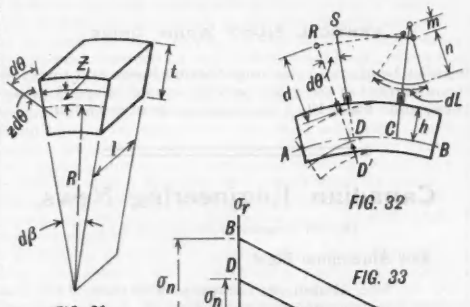


FIG. 31

FIG. 32

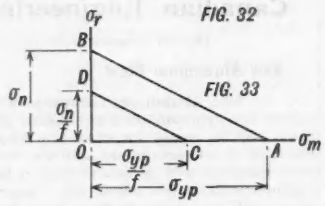


FIG. 33

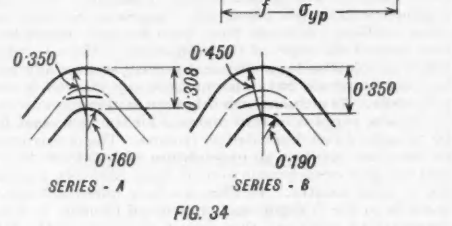
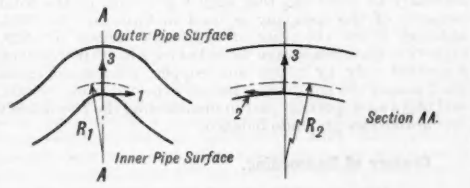


FIG. 34



"The Engineer" FIG. 35

Figs. 31 to 35

Fig. 31—An Element from a Curved Plate in Bending. Fig. 32—A Schematic Diagram of the Action of the Bending Strain Gauge. Fig. 33—To Accompany Section, "The Method of Determining Safe Working Stresses." Fig. 34—The System of Axes and the Location of R_1 and R_2 for a Corrugated Section. Fig. 35—Typical Corrugation Dimensions Obtained from Averaging Measurements.

Where the integrated value of strain over a length is to be indicated the term "total strain" will be used.

A corrugated pipe shape may be considered to be formed by the revolution of the curve of the neutral axis of the corrugated wave shape about a longitudinal axis. In the zone of greatest interest, namely, the crest of a corrugation, the radius of curvature of the surface thus formed is large with respect to the thickness of the pipe wall. The radius of curvature of the corrugation itself is, however, not large with respect to the wall thickness. These two radii are designated as R_2 and R_1 respectively, and are indicated in Fig. 35. This diagram shows a longitudinal section and a hoop section of a corrugation. The system of designating the axes is also shown in the diagram. Thus 1 refers to the longitudinal direction, 2 to the hoop direction, and 3 to the radial direction. These three axes are mutually perpendicular.

The fact that R_1 is small compared to the wall thickness causes a thin shell analysis of strain to be invalid and necessitates knowledge of the position of the longitudinal neutral surface with respect to the inner and outer surfaces, as well as knowledge of the manner of strain distribution through the section, in order to deduce the value of inner surface strain from outer surface measurements.

The strains across the shell thickness are considered as of two classes:—

(*a*) Uniformly distributed or membrane strains,
(*b*) Non-uniformly distributed or bending strains.

These categories include strains in the shell caused directly from the shell loading or those induced in one direction by strain in a direction perpendicular to it. The bending strains are associated with a relative change in angular displacement of the normals to the neutral surface.

Compressive strains are to be considered as negative in sign and tensile strains as positive.

The Strain Distribution.

Notation.

E_{1e} = resultant longitudinal strain at outer surface of shell.

E_{2e} = resultant hoop strain at outer surface of shell.

ε_{1e} = longitudinal bending strain at outer surface of shell.

ε_{2e} = hoop bending strain at outer surface of shell.

ε_{1m} = longitudinal membrane strain constant throughout the shell thickness.

ε_{2m} = hoop membrane strain constant throughout the shell thickness.

The subscript i, used in place of e, refers to the inner shell surface.

The linear strain measured at the shell surface will consist of two components, bending strain and membrane strain. If the bending strain may be determined from the measurement of angular normal displacements, and if the total strain may be determined from measurements of surface extension, the value of the membrane strain may be obtained by subtraction. These considerations lead to the equations for the resultant strains:—

(1) $E_{1e} = \varepsilon_{1e} + \varepsilon_{1m}$.

(2) $E_{2e} = \varepsilon_{2e} + \varepsilon_{2m}$.

These equations define the longitudinal and the hoop strains at the outer surface of the shell. At the inner surface the bending strains will have reversed sign and will, in general, differ in absolute value. The membrane strains at the inner surface will, by definition, be identical in size and value with the membrane strains at the outer surface. Assume that

$$\left|\frac{\varepsilon_{1i}}{\varepsilon_{1e}}\right| = k_1 \text{ and that } \left|\frac{\varepsilon_{2i}}{\varepsilon_{2e}}\right| = k_2,$$

then

(3) $E_{1i} = E_{1e} - \varepsilon_{1e} - k_1\,\varepsilon_{1e}$.

(4) $E_{2i} = E_{2e} - \varepsilon_{2e} - k_2\,\varepsilon_{2e}$.

These equations define the longitudinal and hoop strains at the inner surface of the shell.

In the hoop section the radius of curvature of the neutral surface is large compared to the shell thickness. Hence the position of the neutral surface may be taken as identical with the mid-surface, as with thin shells. The value of k_2 is therefore one, and the bending strain is distributed linearly across the thickness.

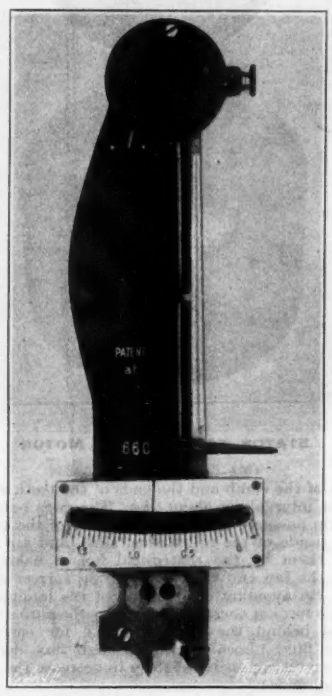


Fig. 36—Huggenberger Tensometer

In the longitudinal section the shell must be considered as thick and the value of k_1 must be mathematically or experimentally determined, since the bending strain distribution across the section will not follow a linear law.

The Bending Strain.

$$(5)\quad \varepsilon_z = \frac{z\,d\,\theta}{(R+z)\,d\,\beta}$$

(by definition from Fig. 31), where ε_z is the bending strain on the surface whose radius of curvature is $(R+z)$, or

$$(6)\quad \varepsilon_z = z\,\frac{d\,\theta}{d\,s'},$$

where $d\,s' = (R+z)\,d\,\beta$.

Methods of Strain Measurement.—The Resultant Strains.—The Huggenberger tensometer was used for measuring directly the resultant strains. A view of this instrument may be seen in Fig. 36. The movement of the knife-edges is magnified approximately 1200 times on the scale. The knife-edges may be adjusted to various gauge lengths. In this investigation gauge lengths of ¼in. in the longitudinal direction and 1in. in the hoop direction were used.

* Dissertation submitted to the Advisory Board of the School of Engineering of the Johns Hopkins University for the degree of Doctor of Engineering.

[21] The writer has benefited by being permitted to refer to Dr. W. M. Coates' unpublished monograph on stress distribution in shells.

Methods of Strain Measurement.—The Bending Strains.—A method of measuring bending strains has been described by Huggenberger.[22] Fig. 37 shows a bending strain gauge constructed after his schematic diagrams. The bases of the instrument legs are fixed to small rods soldered to the surface to be measured. Fig. 32 gives a diagrammatic sketch of the action of the instrument in measuring bending strain. The dotted lines in the diagram indicate the relative positions of the instrument parts after the surface to which it is attached has been placed in pure bending. The angular rotation of the legs of the instrument may be considered as taking place

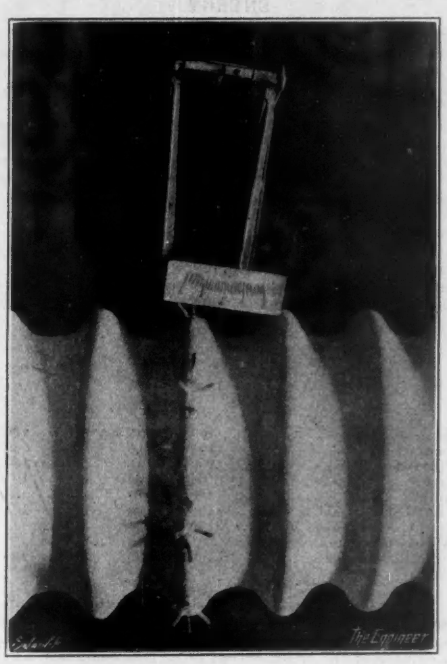


FIG. 37—BENDING STRAIN GAUGE

about the neutral axis M N. From the figure it will be seen that

$$(7)\quad R\,S=(d+h)\,d\,\theta.$$

$$(8)\quad d\,L=R\,S\left(\frac{m+n}{m}\right)=(R\,S)\,g,$$

where g is the magnification factor of the instrument.

$$(9)\quad d\,\theta=\frac{d\,L}{g\,(d+h)}$$

[from (7) and (8)]; then

$$(10)\quad \varepsilon_e=\frac{h}{g\,d\,s'\,(d+h)}\,d\,L$$

[from (9),in (6) assuming $z=h$].

In pure extension the reading of the strain gauge will be simply the relative movement of the rods at the surface multiplied by the multiplication factor, or

$$(11)\quad d\,L'=g\,d\,s'\,\varepsilon_m.$$

If the surface on which the strain gauge is applied is subjected to a combination of bending and tensile strains, then the reading of the instrument will be the sum of the individual readings of each component considered separately, or

$$(12)\quad d\,L''=d\,L+d\,L'.$$

Then

$$(13)\quad d\,L''=g\,d\,s'\,\varepsilon_m+g\,d\,s'\left(\frac{d+h}{h}\right)\varepsilon_e.$$

Generalising equation (1),

$$(14)\quad E_e=\varepsilon_e+\varepsilon_m.$$

Solving equations (13) and (14) as a simultaneous system,

$$(15)\quad \varepsilon_e=\frac{h}{d\,(d\,s')}\left(\frac{d\,L''}{g}-d\,s'\,E_e\right).$$

This equation may be written as applying to the longitudinal and hoop directions, as follows:—

$$(16)\quad \varepsilon_{1e}=\frac{h_1}{d\,(d\,s')}\left(\frac{d\,L''}{g}-d\,s'\,E_{1e}\right)$$

$$(17)\quad \varepsilon_{2e}=\frac{h_2}{d\,(d\,s')}\left(\frac{d\,L''}{g}-d\,s'\,E_{2e}\right)$$

These two equations, in addition to equations (1), (2), (3), and (4), are sufficient to determine the state of strain at the inner surface from measurements made on the outer surface. E_{1e} and E_{2e} are determined directly from the tensometer readings, knowing the multiplication factor of this instrument and the gauge length. The value for $d\,L''$ is taken directly from the reading of the bending strain gauge. The application of these formulæ, however, involves the value of h, which is the distance from the outer surface to the neutral axis and also involves values of k_1 and k_2, which are the absolute values of the ratios of the bending strains at the inner surface to the bending strains at the outer surface in the longitudinal and hoop directions respectively. As has been previously explained, the value for k_2 may be taken as 1.

The value for h_2 may likewise be taken as equal to one-half the wall thickness. The determination of the proper values for h_1 and k_1, however, requires further analysis. The solution for stress (and strain) distribution in curved bars in pure bending is applied to this analysis.

The Determination of the Position of the Neutral Axis and Hence the Values of h_1 and k_1.—The location of the planes of failure in the fatigue tests indicates that the section of principal interest lies at the intersection of a transverse plane passing through the crest of a corrugation with the pipe wall. Because of the initial upsetting of the metal when the corrugation is formed, the outer and inner surfaces of the corrugation in a longitudinal plane will not have the same centres of curvature. For purposes of analysis the outer radius of curvature at the critical section is taken to be equal to the radius of curvature of the inner surface plus the wall thickness at this section. It is further assumed that the corrugation is symmetrical about an axis defined by the transverse plane for a sufficient arc length to encompass the region over which the strain measurements were made. With these approximations and assumptions the solution for stress distribution in pure bending of curved bars is used for the determination of the position of the neutral axis of a longitudinal section of the pipe wall.[23] The radius of curvature of the hoop section is considered to be large in proportion to the radius of curvature of the longitudinal section, and hence to exert no sensible effect on the position of the neutral axis of this latter section.

The value of the tangential stress in a curved bar in pure bending is given by the equation

$$(18)\quad \sigma_\theta=-\frac{4\,M}{N}\left(\frac{-a^2b^2}{r^2}\log b/a+b^2\log\frac{r}{b}+a^2\log a/r+b^2-a^2\right)$$

where M = bending moment, and

$N=(b^2-a^2)^2-4\,a^2b^2\,(\log b/a)^2$, and a, b, and r are the radii of curvature of the inner surface, outer surface, and neutral surface respectively.

The right-hand member of equation (18) was set equal to 0 and solved for r/a in terms of b/a. The result of this solution is shown in Fig. 38. From this graph, knowing

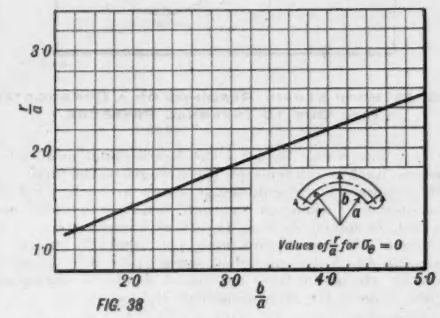


FIG. 38

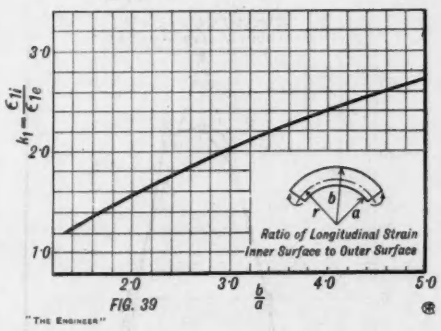


FIG. 39

FIG. 38—POSITION OF NEUTRAL AXIS IN CURVED BARS

FIG. 39—RATIO OF STRAINS IN CURVED BARS

the values of b and a, the value of r, and hence the location of the neutral axis, may readily be determined.

Equation (18) was also solved for simultaneous maximum and minimum values for various values of b/a. The result of the computations are given graphically in Fig. 39, where the values of k_1 may be read directly from the ordinate scale. These values for k_1 are practically the same as would be obtained by assuming a hyperbolic distribution of the bending strain across the shell thickness. In the determination of the values of k_1 and h_1 in the piping under test, the values for the dimensions of the radii of curvature of the inner and outer corrugation surfaces were taken as the average of a large number of measurements of corrugated sections. The average results of these measurements are shown in Fig. 34.

THE ANALYSIS OF STRESS.

Notation.

σ_1, σ_2, σ_3 = normal components of stress parallel to 1, 2, and 3 axis

ν = Poisson's ratio,

E = modulus of elasticity,

ε_1, ε_2, ε_3 = strains in 1, 2, and 3 directions,

σ_n = the value of stress at the endurance limit in reversed flexural stress,

σ_e = an equivalent tensile stress.

The Determination of the Principal Stresses.—It may be seen from considerations of symmetry that the principal axes at the inner surface of the crest of a corrugation are as indicated in Fig. 35. The values of strain along axes 1 and 2 may be determined, as explained in the previous section on strain analysis. It will now be shown, given these strain values in the longitudinal and hoop directions, how the values of the principal stresses may be determined.

It follows from Hooke's Law that the three normal components of stress parallel to three mutually perpendicular axes may be expressed[24]

$$(19)\quad \sigma_1=\frac{\nu\,E}{(1+\nu)\,(1-2\,\nu)}\,e+\frac{E}{1+\nu}\,\varepsilon_1.$$

$$(20)\quad \sigma_2=\frac{\nu\,E}{(1+\nu)\,(1-2\,\nu)}\,e+\frac{E}{1+\nu}\,\varepsilon_2.$$

$$(21)\quad \sigma_3=\frac{\nu\,E}{(1+\nu)\,(1-2\,\nu)}\,e+\frac{E}{1+\nu}\,\varepsilon_3.$$

where

$$(22)\quad e=\varepsilon_1+\varepsilon_2+\varepsilon_3.$$

If the axes selected are the principal axes, the shearing components of stress vanish, and equations (19), (20), and (21) completely define the state of stress on the sides of an element which are parallel to the co-ordinate planes.

The methods of strain analysis yield values for ε_1 and ε_2 (which are equivalent to E_{1i} and E_{2i} determined as described above); thus considering equations (19), (20), (21), and (22), there are four equations and five unknowns. This system of equations is then insufficient to provide a solution for the unknown quantities. In the cases of pipe loadings from bending moments alone, the value σ_3 is clearly 0. Also where the loading is from internal pressure, the value of σ_3 is equal to the value of this pressure. Hence in all cases the value of σ_3 may properly be assumed, and the system of equations solved for σ_1 and σ_2.

With the assumption of the value for σ_3 the values of the principal stresses are now known.

The Maximum-Shear Theory Applied to Fatigue Failures.—The endurance limit of metals in shear, according to data assembled by Moore and Kommers, has a value of about 55 per cent. of the endurance limit in reversed direct stress.[25] This fact indicates that the maximum-shear theory of the failure of metals is a safe approximation for cases where fracture occurs from fatigue.[26]

Since the maximum shearing stress is equal to half the difference between the maximum and minimum principal stresses, the condition for failure from fatigue is

$$1/2\,(\sigma_1-\sigma_2) > 1/2\,\sigma_n,$$

assuming $\sigma_1>\sigma_2>\sigma_3$, and in which σ_n is the endurance limit in reversed direct stress, or in reversed flexural stress, since the value of the endurance limit should be the same in either case. An equivalent tensile stress may be defined as

$$(23)\quad \sigma_e=(\sigma_1-\sigma_2),$$

and hence the maximum shear stress is $\frac{\sigma_e}{2}$.

THE VALUES OF STRESSES DERIVED FROM STRAIN MEASUREMENTS ON CORRUGATED PIPE.

The Results of Strain Measurements.—In order to demonstrate the application of the methods of analysis developed in the preceding sections, strain measurements were made on two corrugations of the tangent section of a quarter bend. Piece B E was erected for this test

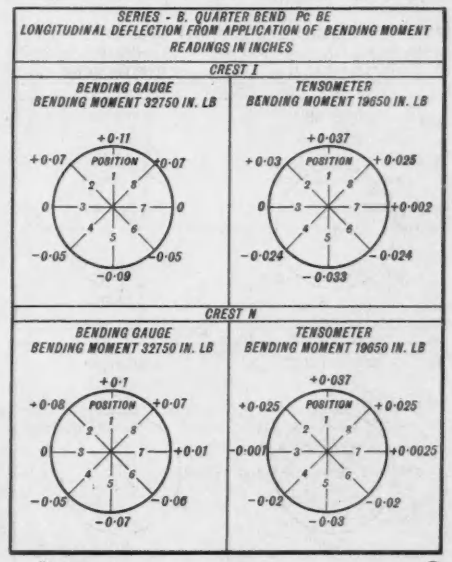


FIG. 40—LONGITUDINAL STRAIN READINGS ON A CORRUGATION CREST DUE TO BENDING MOMENT

with the corrugated tangent leg vertical and measurements were made on the crests of the fourth and sixth corrugations from the bottom of the section. These corrugations were designated by the letters N and I respectively. Two individual methods of loading were employed to produce strain. In one method a bending moment was applied to the pipe with no internal pressure, and in the other internal hydrostatic pressure was applied with no external loading or restraint. In this latter method of loading, the pipe was provided with blank flanged ends.

On each corrugation eight stations for measurements were established. These stations were placed with equal circumferential spacing along the crest of the corrugation. It was necessary to measure the longitudinal strains and hoop strains both with the bending strain gauge and the tensometer at each station for each method of loading.

The results of the strain readings are pictorially tabulated in Figs. 40 to 43, inclusive. The readings reported are the result of the application of 32,750in.-lb. or 19,650in.-lb. bending moment, or the application of 600 lb. per square inch internal pressure as indicated on the

[22] "Ueber die Festigkeit der Gewölbten Böden und der Zylinderschale," by Höhn, Berlin, 1927, Part II, by Huggenberger.

[23] The solution here given is from "Theory of Elasticity," Chapter 3, by S. Timoshenko.

[24] See "Theory of Elasticity," Timoshenko, Introduction, or any text on elasticity.

[25] "Fatigue of Metals," by Moore and Kommers.

[26] See paper by J. J. Guest, *loc. cit.*

diagrams. These values for bending moment and internal pressure have no direct connection with the fatigue tests; they were simply convenient points at which to take measurements. By applying the loading in successive increments, it was determined in each case that the reading was proportional to the loading, beyond the values reported. These readings can therefore be divided by the applied bending moment or by the applied pressure, as the case may be, and yield values of instrument reading per inch-lb. applied bending moment, or lb. per square

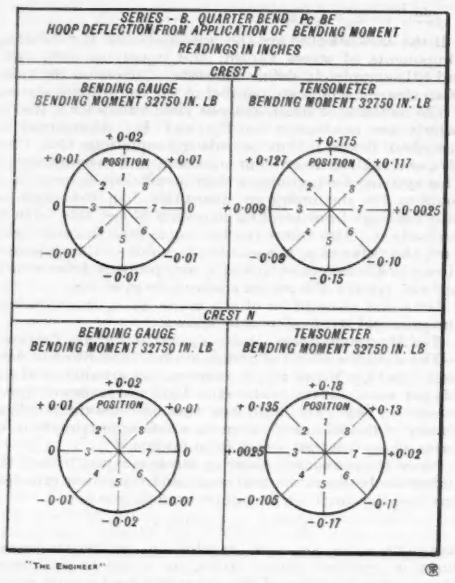


FIG. 41—HOOP STRAIN READINGS ON A CORRUGATED PIPE

inch applied internal pressure. This scheme was employed in carrying out the calculations so that the final results for stress may be multiplied by values for moments or internal pressure to obtain stress values for the selected conditions.

Results Obtained for Values of Principal Stresses and Equivalent Stresses. — With the methods previously described, the external strain measurements were used to derive the values of the principal stresses at each of the stations on each corrugation. In the case of loading due to bending moment, $\sigma_3 = 0$, and in the case of loading due to internal pressure, $\sigma_3 = 400$ lb. per square inch. The results of the calculations for the principal stresses are

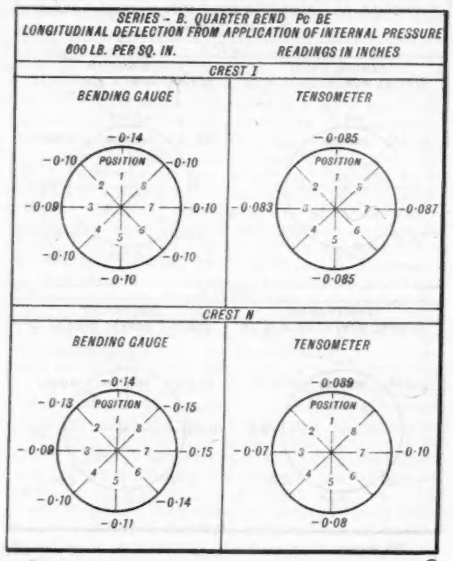


FIG. 42—LONGITUDINAL STRAIN READINGS ON CORRUGATED PIPE DUE TO INTERNAL PRESSURE

tabulated below. The location of the points of measurement with reference to the pipe axes is shown in Fig. 44.

Tabulation of Principal Stresses Due to Application of Bending Moment Only.

Crest of Corrugation N.

Position.	Principal stresses in lb. per square inch per 100in.-lb. moment.		
	σ_1.	σ_2.	σ_3.
1	−74·3	−10·1	0
2	−62·1	− 8·9	
3	− 0·6	0	
4	+35·8	+ 3·5	
5	+48·5	+ 3·2	
6	+45·5	+ 5·9	
7	− 8·0	− 0·8	
8	−52·3	− 6·4	

Crest of Corrugation I.

	σ_1.	σ_2.	σ_3.
1	−84·3	−13·6	0
2	−49·3	− 5·8	
3	+ 0·2	+ 0·8	
4	+33·6	+ 4·0	
5	+68·5	+14·3	
6	+33·3	+ 3·1	
7	+ 1·3	+ 0·6	
8	−52·5	− 7·4	

It may be seen that with one exception, and this in a region of low stress, the greatest principal stress is σ_1 and the least principal stress is σ_3 at each point of measurement. The value of σ_e will therefore, from equation (23), always be equal to the value of σ_1 minus 0, in the case of loading due to bending moment, and will be equal to σ_1 minus the value of the internal pressure in the case of loading due to internal pressure. In the region of highest stress, the value of the radial stress corresponding to pressures for which the pipe was designed is small compared to the value of σ_1, and may be neglected without appreciable error. Hence, for all cases, it may be assumed $\sigma_i = \sigma_1$. This indicates that the hoop stresses, being of

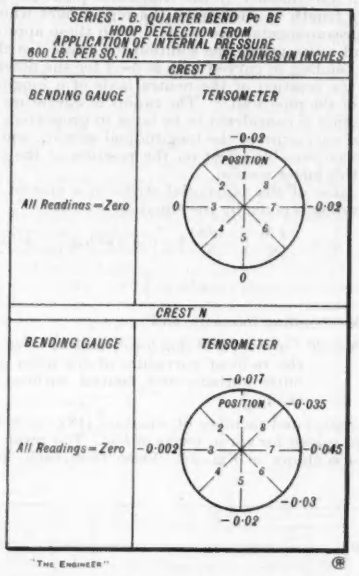


FIG. 43—HOOP STRAIN READINGS ON A CORRUGATED PIPE DUE TO INTERNAL PRESSURE

intermediate value between the longitudinal and radial stresses, have no influence on the strength of the pipe.

The value of the equivalent stress at each point of measurement, when an external bending moment was applied, is shown in Fig. 44. This stress is plotted in values of lb. per square inch per 100in.-lb. moment. Thus, to obtain the equivalent stress induced by a known moment, the value from the curve should be multiplied by the value of the known moment divided by 100.

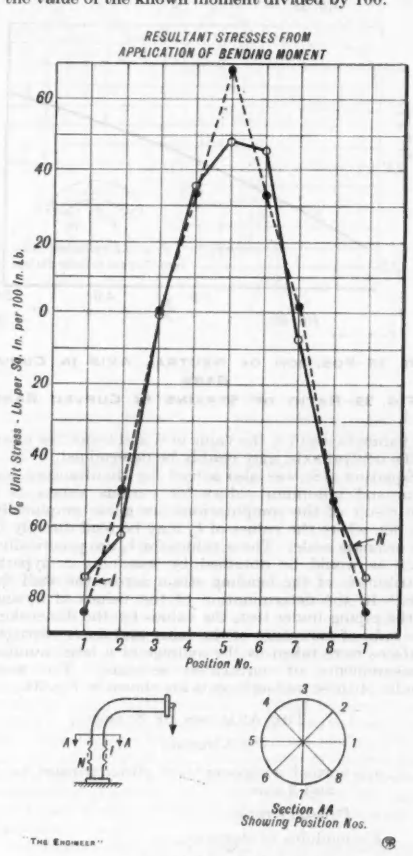


FIG. 44—VALUE OF EQUIVALENT STRESS AT CRESTS OF TWO CORRUGATIONS

The values of the equivalent stresses caused by internal pressure only are as follows:—

Crest N, $\sigma_1 = 52{\cdot}4$ lb. per square inch per lb. per square inch internal pressure.
Crest N, $\sigma_2 = 15{\cdot}1$ lb. per square inch per lb. per square inch internal pressure.
Crest N, $\sigma_e = 51{\cdot}4$ lb. per square inch per lb. per square inch internal pressure.
Crest I, $\sigma_1 = 40{\cdot}1$ lb. per square inch per lb. per square inch internal pressure.
Crest I, $\sigma_2 = 11{\cdot}8$ lb. per square inch per lb. per square inch internal pressure.
Crest I, $\sigma_e = 39{\cdot}1$ lb. per square inch per lb. per square inch internal pressure.

Thus, at the designed working pressure of this pipe, namely, 400 lb. per square inch, the maximum stress observed was over 20,000 lb. per square inch. The significance of these values for stresses caused by internal pressure will be discussed later.

As in the case of stresses caused by bending moments the intermediate stress value, the hoop stress, has no influence on strength.

(To be continued.)

WORLD CONSUMPTION OF ELECTRICAL ENERGY.

An indication of the course of trade and industry throughout the world may be obtained from figures giving the consumption of electrical energy. According to reliable estimates, the year 1929 was characterised by a record level in the consumption of electrical energy in the principal countries, resulting from the favourable situation of world trade at that time. The decrease in the consumption which followed in 1930 and 1931 was arrested in 1932, and from that time an improvement has taken place which has continued down to the end of June this year. Information on this point is contained in the annual report of the Bank für Elektrische Unternehmungen of Zürich, which has widespread financial interests in a number of countries. The report gives the appended figures of the sales consumption in the years mentioned, that in 1929 being taken at 100:—

Sales Consumption.

	1929.	1933.	1934.	1935, first half.
Germany	100	85	101	119
Switzerland	100	114	123	129
England	100	131	150	166
France	100	100	104	105
Italy	100	116	125	135
United States and Canada	100	90	98	105
World production, estimated	100	94	104	111
World production, without North America	100	106	118	130

During the year which ended with June, 1935, the report states, the consumption of electrical energy for industrial purposes in general for the first time increased since the beginning of the crisis, except in certain countries, where the effects of the crisis were felt at a later period. The consumption for domestic uses has developed in a satisfactory manner, as has the sale of energy for the production of steam in trade and industry, although at low prices. While down to 1934 the reductions in the tariffs almost exclusively applied to deliveries for electro-chemistry, power purposes and domestic heating, most of the producing works have recently made important reductions also for supplies for lighting purposes. The effect of the use of electrical appliances in dwellings and the reduction in prices has been a further falling off in the average prices per kilowatt-hour consumed. The report adds that the extension of hydro-electric works and steam power stations in countries where over-production prevails has been brought to a standstill, and this pause will permit of the gradual utilisation of the surplus energy now available.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Wellworthy, Ltd., of Lymington, Hants, has opened a Yorkshire depôt at 82, Woodhouse-lane, Leeds.

Mr. Philip Terry, the only son of Mr. Charles Terry, the chairman of directors of Herbert Terry and Sons, Ltd., Redditch, has now joined the firm.

Mr. Herbert Clark has been appointed managing director to Tangyes Ltd. Mr. Clark started his career with Tannet Walker, Ltd., and after serving with Messrs. Hathorn, Davey and Henry Berry, joined the Rolls-Royce Company, in whose service he spent ten years in America. On his return he entered into association with Messrs. Hardy Spicer and built up the Bendix organisation in this country.

Ferodo, Ltd., has transferred its depôts at Manchester and Newcastle to new and larger premises. The Manchester office and stock depôt has been transferred from 32, Cathedral-street to 16, Jackson's-row, Deansgate, Manchester, 2. Mr. William Morris is in charge of the company's activities in Manchester and Liverpool. The Newcastle office and stock depôt is being removed from 10, Worswick-street to Eldon-street, Barras Bridge, Newcastle-on-Tyne, 2. Mr. J. R. Thompson is in charge of the company's activities in the Newcastle-on-Tyne and Carlisle districts.

LAUNCHES AND TRIAL TRIPS.

Arbroath, motor coaster vessel; built by Caledon Shipbuilding and Engineering Company, Ltd., to the order of the Dundee, Perth and London Shipping Company, Ltd.; dimensions, 165ft. by 30ft. by 14ft.; to carry cargo. Diesel engines of Atlas type; constructed by British Auxiliaries, Ltd.; launch, August 14th; a speed of 10¾ knots was attained on trial trip recently.

Manchester Port, single-screw steamer; built by Blythswood Shipbuilding Company, Ltd., to the order of Manchester Liners, Ltd.; dimensions, 430ft. by 57ft. by 38ft.; to carry cargo and a few passengers. Engines, single reduction geared turbines of Parsons type; pressure 225 lb. per square inch; constructed by David Rowan and Co., Ltd.; launch, July 30th; trial trip, October 7th.

Ratnagiri, twin-screw passenger steamer; built by Caledon Shipbuilding and Engineering Company, Ltd., to the order of Hall, Angier and Co., Ltd., for the Ratnagar Steamship Company, of Bombay; dimensions, 210ft. by 35ft. by 11ft. 6in.; gross tonnage, approximately 650 tons; to carry 1200 passengers, some cargo. Engines, triple-expansion, developing 2000 i.h.p.; constructed by McKie and Baxter, Ltd., Paisley; launch, October 10th.

Tug; built by Henry Robb, Ltd., Leith, to the order of the Indian State of Bhavnagar; dimensions, 86ft. 6in. by 22ft. by 10ft. 6in. Engines, triple-expansion, 650 i.h.p., pressure 200 lb. per square inch; launch, October 11th.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Our Iron and Steel Export Trade.

The Board of Trade Returns for September are somewhat disappointing, since they reveal a sharp fall in exports, which are the lowest since March this year. The total September exports of "Iron and Steel and Manufactures thereof" reached 187,153 tons, compared with 202,497 tons in August and 198,011 tons in September, 1934. The exports of pig iron last month totalled 11,935 tons, which showed little alteration from the August level of 11,307 tons. Of the quantity exported in September, 7702 tons was foundry iron. The exports of sheet bars, tin-plate bars, wire rods, and bright steel bars amounted to 2519 tons, against 2429 tons in August. Particulars of the destinations of these categories are not given. General descriptions of steel were exported to the amount of 17,668 tons and showed comparatively little change from the August figure, which was 17,495. The largest quantity of 3084 tons went to South Africa, India coming next with 2156 tons and then Australia with 1085 tons. The exports of girders, beams, and joists in September reached 2036 tons, the corresponding figure for August being 2761 tons. An increase is shown in the exports of plates and sheets not under ¼in. thick, which for September were 11,814 tons, compared with 10,684 tons for the previous month. Both in September and August, Russia was the best customer with 2383 tons and 2066 tons respectively. There was a slight increase also in the exports of plates and sheets under ¼in. thick, which last month were 13,775 tons and in August 12,530 tons. The largest buyer in this category was the Argentine, with 3509 tons, Canada coming second with 2560 tons and India third with 1097 tons. The total of galvanised sheets exported fell from 22,464 tons to 17,432 tons in September, whilst tin-plates dropped from 28,505 tons to 23,713 tons. The exports of wrought tubes improved in September to 21,685 tons, against 19,079 tons in the previous month. The figures for railway material show a substantial drop to 20,441 tons, compared with 28,979 tons in August. The summary of exports shows that South Africa was Britain's best customer in September, taking 23,272 tons, India coming next with 18,291 tons. Australia was third with 14,089 tons, whilst Canada took 13,810 tons. Amongst foreign countries Denmark was the best customer with 13,213 tons, then the Argentine with 8063 tons.

An Increase in Imports.

The imports of iron and steel in September, as given in the Returns, show a considerable rise, the total being 89,309 tons, compared with 74,314 tons in August. The imports of pig iron, however, fell off substantially last month, the total being 5337 tons, compared with 8457 tons in August, the drop being entirely due to a decline in the quantities sent from India to 3851 tons, compared with 6966 tons in August. On the other hand, the tonnage of imported billets, blooms, and slabs rose to 21,965 tons from 15,926 tons in the previous month. Of this quantity the largest came from Belgium, with 6646 tons, more than double the August total of 3121 tons. The imports from France, however, declined to 5155 tons from 6790 tons in the previous month. There was a rise in the imports from British countries from 5973 tons in August to 6989 tons in September. An increase is also shown in the imports of sheet bars to 7001 tons, compared with 2911 tons in August. Of this quantity Belgium supplied 5467 tons. Wire rods were imported to the extent of 5801 tons, which varied only slightly from the August total of 5673 tons. A sharp increase took place in the imports of girders, beams, joists, and pillars, which in September reached 8675 tons, against 5283 tons in the previous month. Belgium again was the largest importer with 5187 tons, France coming next with 2688 tons. There was a decline in the quantities of hoop and strip imported in September to 3407 tons from 5872 tons in August. The imports of plates and sheets rose from 3315 tons to 4721 tons in September. Wrought tubes were imported to the extent of 2323 tons in September, against 1379 tons in the previous month. Comparatively little change was shown in the quantity of railway material brought into the country, which in September amounted to 1144 tons, compared with 1069 tons in August. Of the total imports of iron and steel, Belgium supplied by far the largest quantity with 39,455 tons, "other British countries" coming next with 10,890 tons. France was third with 10,798 tons. The quantities imported from Luxemburg totalled 6879 tons.

The Pig Iron Market.

There has been no decline in the activity which lately developed in this market. The demand has improved to some extent, as there is more inclination shown by consumers to buy forward than for some weeks. This is not so much because contracts have run out as that users now take the view that they are not likely to suffer from booking long-date contracts and have therefore given up their policy of buying from hand to mouth. On the other hand, the producers are showing a certain amount of reluctance to commit themselves far ahead. On the North-East Coast the situation has developed no fresh features, and the makers claim that the greater part of the iron in stock is earmarked for delivery and that most of their output up till next March has been disposed of. It seems evident that there is little unsold iron left in stock, but less nervousness is shown on this account than a month or two ago, since in the intervening period many of the important users have to a great extent covered their requirements. The Midland producers are experiencing a satisfactory demand. Business in Northamptonshire iron has been on a good scale for a long time, and it is understood that the stocks are not more than sufficient to provide a margin of safety. The position is not so good at the Derbyshire blast-furnaces, but in that district also withdrawals from stock are taking place and lately there has been a fair amount of forward contracting by users. The Midland general engineering trades are taking a considerable tonnage of iron and recently their requirements of specially refined iron seem to have broadened. Quotations for this description vary from £5 5s. to £7. Steady conditions rule in the Sheffield pig iron market, but most of the business transacted has been for immediate delivery, as consumers are to a great extent covered by contracts. In Lancashire, whilst the consumption of pig iron has been maintained, a seasonal falling off is noticeable in the requirements of the light castings makers. The Scottish producers are meeting with a strong demand, which has been kept at its present rate for a long time and shows no signs of relaxing. Business in hematite has been on a good scale since the new quarter opened and a number of contracts have been placed for delivery until the end of March, 1936. The stocks in the makers' hands on the North-East Coast are low, but nevertheless the demand is sufficient to occasion frequent withdrawals.

British Iron and Steel Production.

The monthly statement of the British Iron and Steel Federation for September presents a very satisfactory picture of the condition of the iron and steel trade. The production of steel was the highest since October, 1929. Steel output in September is usually at a high level, and last month showed an increase of 120,000 tons over that for September, 1934. The production of pig iron totalled that month 529,600 tons, against 543,400 tons in August and 500,300 tons in September last year. The output included 128,500 tons of hematite, 270,300 tons of basic, 115,600 tons of foundry, and 8300 tons of forge pig iron. Steel ingots and castings were produced to a total of 855,900 tons, compared with 759,900 tons in August and 734,700 tons in September, 1934. At the end of September there were ninety-seven furnaces in blast, two having been blown out and one put in during the month. The report does not give particulars, but one of the furnaces blown out was at the works of the British (Guest, Keen, Baldwins) Iron and Steel Company, Ltd., the other at the Goldendale Iron Company, Ltd., Goldendale, Staffs., whilst the one put into operation was at the Redbourn works of Richard Thomas and Co., Ltd. The following table shows the average monthly production over a period of years and the output for the past four months :—

		Pig iron, tons.	Steel, tons.
1913—monthly average	..	855,000	638,600
1920 " "	..	669,500	755,600
1929 " "	..	632,400	803,000
1932 " "	..	297,800	438,500
1933 " "	..	344,700	585,300
1934 " "	..	498,200	738,300
1935—June	..	529,300	770,000
July	..	547,300	803,300
August	..	543,400	759,900
September	..	528,600	855,900

The North-East Coast and Yorkshire.

The works on this coast are producing more steel than any other district, and in nearly all departments carry sufficient orders on their books to ensure production well into the first quarter of next year. During the past week the sales have been good but rather less than the total produced. The possibility of higher prices, however, may bring about a fresh wave of buying. A spurt in demand is the more likely as many of the large consumers, especially the constructional engineers, are well placed as regards work and have some important jobs in sight. Lately the tendency has been to buy structural steel on a hand-to-mouth basis to supplement existing contracts; but this attitude may quickly change if the price question is seriously discussed. The recent orders for ships placed with North-East Coast yards have brought fresh work to the steel makers, but the demand from the shipbuilding industry is still disappointing. The demand for semis at the moment is as much as the works producing this class of material can cope with, and although it is said that some of the Continental quota for the second period has been anticipated it appears to have made no impression upon the volume of business placed by British consumers. Many of the latter are complaining of delays in delivery from the home works, and the position in this respect does not seem to improve. The recent expansion in the demand for steel sheets has been maintained, and more orders have come to hand both on home and export account than for some time. Nevertheless, the requirements of the overseas markets do not fulfil expectations, and reports that thin sheets will be brought under control by the Anglo-Continental export agreement have not stimulated buying. Active conditions rule in the Yorkshire steel market. The works, almost without exception, are busily employed, particularly in the Sheffield district. There has been a lull in new business in a few departments, but the volume of deliveries has not been affected. Consumers, in fact, are, in some cases, asking for their orders to be accelerated. There is a good demand for billets of all descriptions, and lately there has been an improvement in the call for the higher carbon qualities.

Current Business.

The Whessoe Foundry and Engineering Company, Ltd., of Darlington, and Grant and Livingston, of Ilford, have secured a contract from the Shell-Mex and British Petroleum Company, Ltd., for the erection of a petroleum storage tank, with a capacity of 1,500,000 gallons, at Jarrow. The small tool works of the English Steel Corporation, Ltd., Openshaw, Manchester, has obtained an order for 1000 tapered bridge reamers for a British shipyard. Harland and Wolff, Ltd., of Belfast, have secured an order for a cargo steamer of 5000 tons from Huddart, Parker, Ltd. An order for a grab-hopper dredger has been placed with Lobnitz and Co., Ltd., of Renfrew. Amongst the contracts, totalling together nearly a million pounds, which have been placed by the New Zealand Government and shipping interests, are twenty-one electric transformers with the General Electric Company, Ltd., Birmingham; seven Diesel railcars with Leyland Motors, Ltd., Kingston-on-Thames; turbine plant with C. A. Parsons and Co., Ltd., Newcastle-on-Tyne (amounting to £40,000), and boiler plant with Richardsons, Westgarth-Brown Boveri, Ltd., Hartlepool (amounting to £40,000). The French Government has authorised the Scientific Instrument Manufacturers' Association of Great Britain, Ltd., to issue certificates to shippers in respect of the following scientific instruments which are subject to quotas when imported into France :—Simple surveying instruments; dividing machines; house barometers; apparatus for physical and chemical demonstration for schools and colleges; apparatus for physical and chemical researches and analyses; surveying instruments for geodesy, topography, and measurement of angle. The Department of Overseas Trade reports that the following contracts are open for tender :—Argentine State Oilfields Directorate: 15,754 cases of tin-plates in various sizes; valves and accessories, including valves for casing pipe, petroleum economisers for control valves, sluice, globe, needle and check valves, straight-through cocks, pressure gauge cocks (Buenos Aires, November 5th). Egypt, Ministry of Communications: Construction of a metallic swing bridge near Dahtamoun (Cairo, November 16th); similar bridge near Beltan (Cairo, November 23rd).

Copper and Tin.

The electrolytic copper market seems to have settled down after the abrupt fluctuations of last week, and the demand, while not quite so strong, has a more healthy tone. The American domestic quotation remains firm at 9·25c., whilst the export price has ruled at around 8·77½c., or £40 to £40 5s. c.i.f. Sales in the United States are reported to have reached about 55,000 tons in the first fortnight of October, and as a result there has been less inclination on the part of American producers to press copper for sale in Europe. There is still a certain amount of nervousness in the market regarding the effect sanctions will have upon the position, since whilst a considerable proportion of the copper sold to Italy has been on a cash basis a good tonnage remains to be delivered. If delivery of this metal were prevented it would have to be disposed of somewhere else and so might disorganise the market for a time. In ordinary circumstances this fear might have created a "bearish" influence, but the view is held that the position is intrinsically sound and that further advances may be expected. It is pointed out that although the American consumers have bought heavily for forward delivery, the Continental consuming industries are not well covered largely because of the difficulty of arranging terms of payment, and for this reason Continental buying is likely to be spread over a long period. In the London standard market prices have slipped back on the cessation of the rather excited buying of last week. The profit-taking sales and a general inclination on the part of speculators to await developments as a result of the imposition of sanctions have been chiefly responsible for the reaction. . . . The scarcity of prompt metal in the tin market has created an extraordinary situation. Covering operations caused a sharp demand for spot tin, and as a consequence the price advanced until it stood at £20 over the three months figure, whilst owing to the absence of sellers the official prompt quotation could only be fixed within a limit of £5, the price at the beginning of the week being £243 to £248. The demand from consumers has been steady, but has displayed no particular feature. American buying has been spasmodic and business with the Continent has been on a restricted scale. It is anticipated that by the end of the month the increase in the quota will result in fresh supplies being available, and it is expected that the statistics will show an increase of about 1000 tons in the visible supply.

Lead and Spelter.

Prices in the lead market have fluctuated violently during the past week or two, largely as a result of reports as to the nature of the sanctions which were to be imposed upon Italy and the obstacles which would be placed in the way of trading with that country. The downward movement in this market was not altogether unexpected, but just as the rise was scarcely warranted by the position, so the fall seems to have been overdone. The industrial demand for the metal is extremely good, and whilst the pipe and sheet makers continue to take heavy quantities, the cable makers have also been more active buyers than for a long time. Supplies do not seem to be more than the market requires, and the arrivals of Empire lead apparently are passing directly to consumers in satisfaction of old contracts, so that no surplus metal is available for the market. The stringency of the position is indicated by the fact that there is now no contango. Deliveries of lead continue to be made from warehouse, and metal is being taken out of bond to meet Russian purchases. . . . Whilst there is a fair industrial demand for spelter, supplies of metal are ample to meet the needs of the market. It would almost seem that the price movements have been governed by the sympathetic influence exerted by conditions in the lead market. More speculative interest has been noticeable of late, and on the reaction which affected most non-ferrous metal markets there was a considerable amount of liquidation.

Current Prices for Metals and Fuels.

Makers' official home trade prices per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. Coast—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 10 6	3 2 0
No. 1	3 11 0	3 3 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/– rebate*)	3 10 0	—
Midlands—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/– rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 13 6	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/– rebate*)	3 10 0	—
N.W. Coast—	3 14 0 d/d Glasgow	
Hematite Mixed Nos.	3 18 6 „ Sheffield	
	4 4 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
Lancs.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. Yorks.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
Midlands—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 10 0	—
No. 4 „	8 0 0	—
Scotland—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. Coast—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home.	Export.
London and the South—	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 6	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 10 0	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 5 0	—
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 7 6	7 15 0

STEEL (*continued*).

	Home.	Export.
Glasgow and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates	9 5 0	—
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	8 5 0

Ireland—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G to 13-G., f.o.r.	9 10 0	8 15 0
14-G. to 20-G., d/d	10 15 0	9 0 0
21-G. to 24-G., d/d	11 0 0	9 5 0
25-G. to 27-G., d/d	11 12 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £12 15s. 0d., c.i.f. India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18/9.
Tin-plate Bars, d/d South Wales Works, £5 5s. 0d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 to 250 tons	5 17 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 0 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 0 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·50 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose) 76 p.c.	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, October 16th.

Copper—		
Cash	£34 17 6 to £34 18 9	
Three months	£35 2 6 to £35 3 9	
Electrolytic	£39 0 0 to £40 0 0	
Best Selected Ingots, d/d Birmingham	£40 10 0	
Sheets, Hot Rolled	£68 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10½d.	10½d.
„ Brazed (basis)	10½d.	10½d.
Brass—		
Ingots, 70/30, d/d Birmingham	£33 0 0 to £34 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9½d.	9½d.
„ Brazed	11½d.	11½d.
Tin—		
Cash	£228 0 0 to £229 0 0	
Three months	£217 0 0 to £217 10 0	
Lead: Cash and forward	£18 2 6	
Spelter	£16 2 6 to £16 8 9	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

Lanarkshire—	Export.
(f.o.b. Grangemouth)—Navigation Unscreened	13/3 to 13/6
„ Glasgow—Ell	15/–
„ „ Splint	17/6
Ayrshire—	
(f.o.b. Ports)—Steam	12/– to 12/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	14/– to 14/3
Unscreened Navigation	12/9 to 13/–
Lothians—	
(f.o.b. Leith)—Hartley Prime	13/3 to 13/6
Secondary Steam	12/6 to 13/–

ENGLAND.

Yorkshire, Manchester—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	14/6 to 17/6
Northumberland, Newcastle—	
Blyth Best	15/– to 15/6
„ Second	13/9 to 14/–
„ Best Small	10/6 to 11/–
Unscreened	12/6 to 13/6
Durham—	
Best Gas	14/8
Foundry Coke	19/– to 20/–

Sheffield—	Inland.
Best Hand-picked Branch	23/– to 25/–
South Yorkshire Best	20/– to 22/–
South Yorkshire Seconds	17/– to 18/–
Rough Slacks	8/– to 9/–
Nutty Slacks	7/– to 8/6

Cardiff— SOUTH WALES.	
Steam Coals:	
Best Admiralty Large	19/6
Best Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Bunker Smalls	12/6 to 13/6
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	27/– to 40/–
Furnace Coke	19/– to 22/6
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	36/– to 40/–
Machine-made Cobbles	41/– to 48/6
Nuts	40/– to 48/6
Beans	25/– to 30/–
Peas	19/– to 23/–
Rubbly Culm	11/6 to 12/–
Steam Coals:	
Large Ordinary	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Engineering Trades.

APART from orders that are being executed for the State, there is little activity in the engineering trades, and works are generally running on short time, with hopes of an early improvement further diminished by the disturbed outlook. The only activity is provided by requirements for national defence. There are so many factors in the situation likely to delay recovery that manufacturers can only, for the moment, deal with one of them and try to lower production costs by modernising plants and cutting down overhead charges; but the financial stringency ties down many makers to economies that do not permit of much being done to increase manufacturing efficiency. Another cause of trouble is the dearth of skilled workers resulting from the departure of foreign labour from the country since the industrial crisis set in. The longer the depression lasts the more difficult it will be to procure skilled workmen in the event of a sudden revival of trade. With a progressive revival it is thought that some improvement in the existing apprenticeship system would allow of a sufficient number of trained hands being turned out without its being necessary to resort to a massive importation of labour, which, experience has shown, offers some inconvenience and, perhaps, risk in a country where the entire industrial resources are liable to be mobilised. Nevertheless, there are some industries that cannot dispense with specialised foreign labour. Meanwhile, statistics show little sign of improvement in the engineering trades. Detailed figures just published of foreign trade during the first six months of the year reveal a further decline in imports and exports of machinery of all kinds, including electrical, machine parts, rolling stock and boiler work, the imports having declined from 416,857,000f. in the first half of 1934 to 291,364,000f. The monthly returns indicate that the second half of the year is likely to show a further decrease.

The Merchant Marine.

After the launching of the "Ville d'Alger" at Saint-Nazaire, the sister ship "Ville d'Oran" last week left the stocks at the Ciotat yard of the Société Provençale de Constructions Navales. The ship has a length of 147 m., a width of 19 m., and a gross tonnage of 10,200. The contract speed is 23 knots. These two vessels were built by order of the Government, which required them for service between Marseilles and Algeria to be used as fast troopships, if necessary. The cost of building the "Ville d'Alger" was defrayed by the Compagnie Générale Transatlantique, in which, as is known, the State has a controlling interest, and the State paid for the construction of the "Ville d'Oran." The latter ship will be run in common by the Compagnie Générale Transatlantique, the Compagnie des Transports Maritimes, and the Compagnie de Navigation Mixte. This is a first experiment in combining the activities of smaller shipping companies with those of what is regarded as the national company, and it implies a gradual consolidation of shipping interests under the indirect control of the State. The suppression of some minor unprofitable services is also a part of this policy of the Ministry of the Mercantile Marine to cut out unnecessary charges on the State, and ports like Marseilles and Bordeaux are protesting against an action which, they declare, is seriously detrimental to their interests.

The North American Air Route.

In view of the trial flight across the North Atlantic which it is hoped to make with the huge seaplane "Lieutenant-de-Vaisseau-Paris," the French Air Ministry has sent an expert to the Azores to investigate the facilities offered by those islands as a half-way refuelling station. This step does not imply that the French Government is assured of obtaining leave from the Portuguese Government to utilise the Azores for that purpose, for while the company "Air France" appeared likely at one time to succeed in obtaining a concession through its Portuguese subsidiary company, the negotiations fell through, and it was only recently that the Portuguese Government could be induced to authorise an expert from the French Air Ministry to visit the Azores in order to see if they offered conveniences for a service between Paris and New York by way of Lisbon. Meanwhile, the seaplane "Lieutenant-de-Vaisseau-Paris" is undergoing trials after repairs of damage sustained when taking off at Havre at the time of the "Normandie's" inaugural voyage. Incidentally, it is stated that the "Normandie" will go into dock at Havre for the winter on returning from her next voyage, when she will undergo revision and some modifications. Havre has been selected for the work because, it is affirmed, it would cost far too much to dredge the channel at the mouth of the Loire leading to the combined lock and dry dock at Saint-Nazaire.

The Vosges Tunnels.

Of the tunnels being driven through the Vosges between Saint Maurice and Wesserling for the Est Railway Company and between Saint-Marie-aux-Mines and Saint-Dié for the Alsace-Lorraine Railways, having lengths respectively of 9020 and 7835 yards, the latter continues to make progress, but work on the Saint-Maurice-Wesserling tunnel has been stopped for some time by the contractors finding that their original estimate of cost has been largely exceeded by the presence of hard rock that increases the difficulty of the undertaking. An appeal has been made to the Minister of Public Works to enable operations to be resumed by providing money out of the relief fund. Unless this help is forthcoming it is impossible to foretell when work can be started again, and there is a good deal of local agitation over so many men being thrown out of employment, while the suspension of work on the tunnel for, possibly, an indefinite period is a serious matter for the railway company. The Minister of Public Works does not appear able at present to see his way to provide money out of the relief fund, which has already been fully allocated and is to be employed for the next two or three years more largely on road making and other operations employing unskilled men than on public works of a less general character.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

434,370. April 24th, 1934.—RADIATORS, C. Mather, 353, The Cliff, Higher Broughton, Salford, Lancs.

In order to facilitate the repair of damaged radiators, the inventor arranges the tubes in groups and connects each group individually with the headers by means of sub-headers. The

Nº434,370

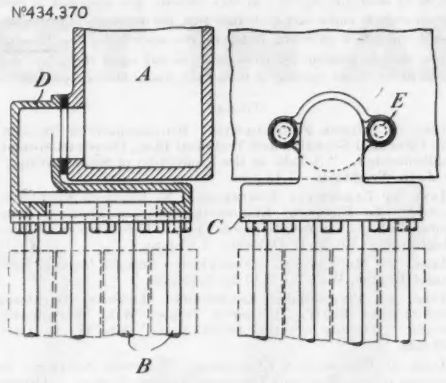
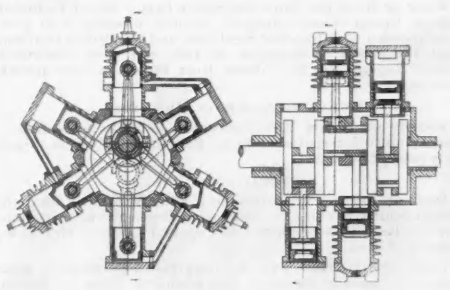


illustration shows only the top of the radiator, with the main header A. The tubes B, which, it will be seen, are gilled, are expanded into the tube plate C of the sub-header D. The sub-headers are attached to the main headers by joints E, which are easily broken if it is necessary to remove any pipe for repair. —*August 30th*, 1935.

434,374. May 11th, 1934.—TWO-STROKE ENGINES, W. McClelland, 86, Cavendish-drive, Rock Ferry, Chester.

The chief aim of the designer is to provide a fully balanced radial engine of the two-stroke type. He employs two groups

Nº434,374



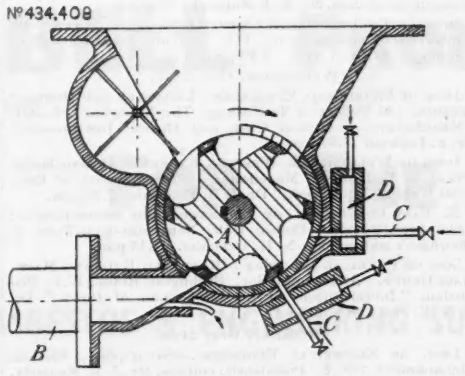
of three cylinders, each working on to a common crank, and two groups of supercharging cylinders working on a pair of opposed cranks. The end view shows how the reciprocating masses are balanced on the assumption that they are in one plane.—*August 30th*, 1935.

CRANES AND CONVEYORS.

434,408. April 23rd, 1935.—PNEUMATIC CONVEYORS, F. J. L. F. Constantin, 105, Rue Lafayette, Paris, Xe, Seine, France.

Some materials when conveyed pneumatically tend to clog together in the conveying pipe. As a consequence the inventor feeds the material into the conveyor by means of a star wheel A.

Nº434,408



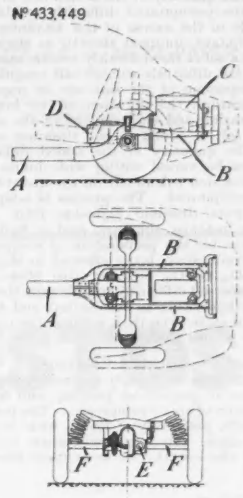
As the wheel rotates its pockets are supplied with compressed air before they reach the outlet to the conveyor B. The air is supplied either by direct single jets C C or through multiple jets through the walls of the casing from the distribution boxes D D.—*August 30th*, 1935.

MOTOR CARS AND ROAD TRAFFIC.

433,449. November 13th, 1933.—MOTOR CAR SUSPENSION, Daimler-Benz Aktiengesellschaft, Stuttgart-Untertürkheim, Germany.

This specification covers the general arrangement of the driving unit of a car in which the engine is placed at the rear. The main member of the frame comprises the tube A, which is bifurcated at the rear—see B B—and is swept up over the back axle. Between the arms of this fork the unit comprising the engine C, the gear-box D, and the differential E, is mounted

Nº433,449



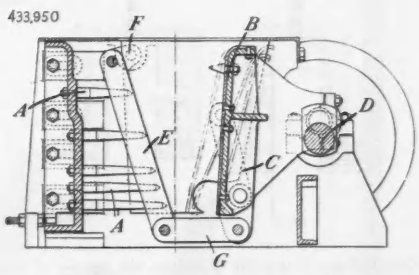
on rubber buffers. The weight of the vehicle is transmitted to the articulated half-axles F F through the unguided helical springs shown.—*August 13th*, 1935.

CRUSHING AND GRINDING.

433,950. February 20th, 1934.—COAL BREAKERS, British Jeffrey-Diamond, Ltd., Stennard Works, Wakefield, Yorks., and J. W. Pickering, 16, Townley-road, Lupset, Wakefield.

This is a machine for breaking up large coal by splitting it, rather than by crushing. The splitting is effected by the picks A, against which the coal is forced by the reciprocation of the plate

433,950



B. This plate is slung on the links C and is reciprocated by the excentric D. Facing the plate B there is a grid of bars E arranged between the picks. These bars are pivoted to the frame at F, and are connected with the lower part of the plate B by the bars G. The bars E and G provide a screen which decides the size of the broken coal. The action of the linkage is such that the plate and the bars work about an indeterminate axis, and the machine does not get choked.—*August 20th*, 1935.

METALLURGY.

434,400. March 26th, 1935.—NIOBIUM ALLOYS, Electro Metallurgical Company, 30, East Forty-second-street, New York, U.S.A.

The invention is a process for producing alloys of niobium (columbium) from materials which contain oxides of niobium. It comprises, broadly, reducing oxydic ores or compounds of niobium with silicon or silicon alloys, the silicon preferably being so proportioned to the charge that a selective reduction of niobium compounds in respect to compounds of tantalum and titanium occurs. The inventors say that they have found that in order to obtain an optimum reduction and recovery of niobium consistent with a strongly selective reduction of niobium compounds in preference to tantalum and titanium, it is necessary so to proportion the silicon in the charge that there is enough silicon to yield an alloy containing a niobium to silicon ratio between about 6 to 1 and about 12 to 1. Preferably this ratio is between 7 to 1 and 9 to 1. If the optimum proportion of silicon is used it is possible to recover as metal upwards of 75 per cent. of the niobium originally present in the charge, and also to produce an alloy in which the ratios of niobium to tantalum and of niobium to titanium are considerably higher than in the ore or compound smelted. If greater proportions of silicon than the optimum are used the resulting alloy will contain greater proportions of tantalum and titanium; and if smaller proportions of silicon are used the recovery of niobium will be poorer. The process of the invention is suitably effected in an electric furnace. Basic slags are preferably used, but neutral or acidic slags may be used with some success. The silicon reducing agent may be either silicon metal or a silicon alloy. Ferro-silicon, chromium-silicon, ferro-chromium-silicon, or niobium-silicon, and, in general, any alloy of silicon with metals desired or unobjectionable in the final product may be used for the reducing agent. The quantity of silicon required for the reduction of the ore or compound of niobium may be estimated roughly from the theoretical requirements for the reduction of the metal oxides and oxydic compounds contained therein. An allowance should be made for the amount of silicon oxidised by the oxygen contained in the furnace atmosphere, and, of course, for the silicon desired in the final alloy. The precise proportions to be used under any given set of conditions may be determined by trial. Iron, or nickel, or chromium, or any other metal, or any mixture of metals, may be added to the product of reduction, to produce an alloy of the desired composition, either by effecting the reduction in the presence of a metal bath or by adding one or more of those metals during or after the reduction.—*August 30th*, 1935.

MISCELLANEOUS.

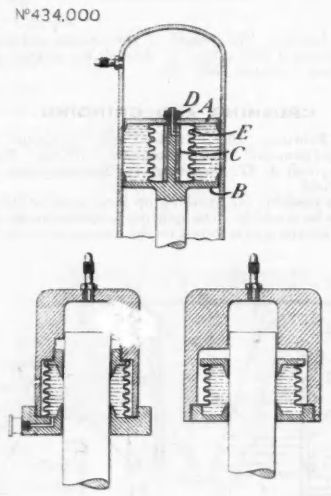
433,960. February 23rd, 1934.—TITANIUM PIGMENTS, Titangesellschaft m.b.H., Leverkusen, Germany.

This invention relates to improvements in the manufacture of titanium pigments by precipitating titanium hydroxide from titanium salt solutions in the presence of finely dispersed salts of titanium which are difficultly soluble in dilute mineral acids. Such salts, which are difficultly soluble in mineral acids, are, for example, titanium phosphates, titanium potassium

sulphates, titanium potassium fluorides, titanium silicates, and titanium zirconium compounds. These salts are used in a dispersed state which is obtained by adding to a titanium salt solution a small amount of a solution of a soluble salt or the corresponding acid which forms a difficultly soluble salt with the titanium. The quantity of the added salt or acid must be so chosen that the precipitated difficultly soluble salt is still colloidally soluble in the excess of the titanium salt solution used. The precipitate obtained thereby is stirred until it is transformed into a sol of the difficultly soluble salt. On heating the sol obtained the difficultly soluble salt coagulates, whereby the degree of dispersion of the salt can be regulated by the degree of temperature, the duration of the heating process, and the concentration and acid content of the solution. The finely dispersed salt is added to the titanium solution to be precipitated. The quantity of the added difficultly soluble titanium salt can be varied within wide limits; in general, 2 to 6 per cent. is added calculated on the quantity of titanium dioxide to be precipitated. The process is adaptable for the preparation of pure titanium pigments from titanium salt solutions, as, for instance, sulphuric acid or hydrochloric acid solutions, and also for the preparation of composite titanium pigments, the precipitation being effected in the presence, for instance, of $BaSO_4$, $CaSO_4$, SiO_2, or other fillers. By the use of these finely dispersed difficultly soluble salts the precipitation of the titanium hydroxide is accelerated and the grain size becomes finer and more even than without the use of the finely dispersed salts.—*August 23rd*, 1935.

434,000. January 5th 1935.—Packings, J. Mercier, 131, Boulevard de la Seine, Neuilly-sur-Seine, Seine, France.

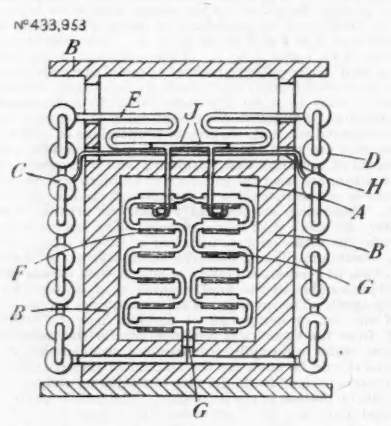
This is a piston, or piston-rod, packing, and is illustrated as applied to the piston of an air compressor. The piston comprises two discs A and B, preferably of metal, with inwardly turned sharp scraping edges. They are held apart by the sleeve C and clamped by the nut D. Between them there is arranged



a flexible bellows E, possibly of leather, the interior of which is in communication with the compressor cylinder by way of a port in the rod. The space between the bellows and the cylinder wall is filled with grease, which is naturally subjected to the compression pressure. This is said to prevent gas leakage, while the scraping edges of the discs minimise the loss of grease, the two lower views show the idea applied to rod packings.—*August 23rd*, 1935.

433,953. February 23rd, 1934.—Absorption Refrigerating Apparatus, E. Altenkirch, Bahnhopstrasse 56, Neuenhagen, near Berlin, Germany.

It is claimed that this refrigerating apparatus can be worked by means of the radiant heat of the sun. It comprises a condenser, an evaporator, and two absorber-generators, each acting as an absorber during the working periods when the other acts as a generator, wherein an inert gas circulates successively through the absorber-generator acting as a generator, the condenser, the absorber-generator acting as an absorber, and the evaporator, its direction being reversed between successive working periods. Conveniently the flow of gas is produced by the heating of the absorber-generator acting as the generator, or by the cooling of the absorber-generator acting as the absorber. In this case the flow of gases may be made to reverse automatically when the heating is changed over, as, for instance, by the passage of the sun over the meridian. In the morning



the sun shines on the absorber-generator chambers D, facing east, while the chambers C are in the shade. The heating of the chambers D drives off refrigerant from the absorbent into the inert gas, with which it passes upwardly. In the uppermost chambers the concentration of the refrigerant is very high, since in the preceding stage the gas mixture coming from the condenser was saturated with refrigerant from the absorbent. The mixed gases are cooled in the condenser E, which is situated under the shade roof B. The refrigerant liquid flows through the pipes J into the uppermost evaporator vessels F and G. The inert gas passes from the condenser into the uppermost of the absorption chambers C in which further refrigerant is removed from it and produces a high concentration particularly in the uppermost chambers C in preparation for the next period of operation. As the gas passes downwardly through the chambers C, the concentration of refrigerant in the mixture is gradually reduced as it encounters portions of absorbent progressively poorer in refrigerant. The partial pressure of refrigerant in the lowest chambers C will only be very low, since in the preceding period of operation these chambers were traversed by the gas mixture coming from the evaporator and containing a very low proportion of refrigerant corresponding to the very low temperature in the evaporator. The gas mixture descending through the chambers C therefore enters the evaporator with a very low proportion of refrigerant, and after being cooled in the heat exchanger G passes through the evaporator in which the liquid refrigerant evaporates into it. On leaving the evaporator the gas mixture is heated by the heat exchanger G and returns to the lowest of the absorber chambers D. In the afternoon the sun shines on the west side of the apparatus and warms the chambers C, thereby reversing the gas flow. The actual refrigerating chamber is, of course, shown at A.—*August 23rd*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Inst. of British Foundrymen: Middlesbrough Branch.—In Cleveland Scientific and Technical Inst., Corporation-road, Middlesbrough. "A Talk on the Production of Steel Castings," Mr. J. G. Wrightson. 7.45 p.m.

Inst. of Electrical Engineers: N. Eastern Students' Section.—In Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-upon-Tyne. Chairman's address, "Lightning," Mr. T. D. Oswald. 7.15 p.m.

Inst. of Mechanical Engineers.—Annual Dinner, Connaught Rooms, W.C. 2. 6.45 for 7.15 p.m.

Inst. of Production Engineers: London Graduate Section.—At British Industries House, W.1. Presidential address, "Tooling for the Small Shop," Mr. W. G. Carr. 7.30 p.m.

Inst. of Production Engineers: Western Section.—In Common Room, Merchant Venturers' College, Bristol. "Optical Measuring Instruments," Mr. Franz Loewen. 7.15 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. Informal meeting. "The Thames Barrage," Mr. J. H. O. Bunge. 7.30 p.m.

Manchester Technology Old Students' Assoc.—In College of Technology, Manchester. Film, "The Laying of the Iraq Pipe Line," Dr. A. E. Dunstan. 7.30 p.m.

North-East Coast Inst. of Engineers and Shipbuilders.—At the Literary and Philosophical Soc., Newcastle-upon-Tyne. Annual general meeting. Address, Dr. J. T. Batey. Cinematograph film. 6 p.m.

Physical Soc.—At Imperial College of Science and Technology, S. Kensington, S.W.7. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.; meeting, 4.45 for 5 p.m.

West of Scotland Iron and Steel Inst.—Royal Technical College, George-street, Glasgow. Council meeting, 6.45 p.m. Joint meeting with Iron and Steel Inst. and the British Iron and Steel Federation. Discussion on Iron and Steel Institute's Special Report, No. 10, "Waste Heat Boilers in Open-hearth Practice." 7.15 p.m.

TO-DAY TO SATURDAY, OCT. 26TH;

Society of Motor Manufacturers and Traders, Ltd.—Twenty-ninth International Motor Exhibition, Olympia. Open daily (except Sundays).

SATURDAY, OCT. 19TH.

Inst. of British Foundrymen: East Midlands Branch, Lincolnshire Section.—Technical College, Monks-road, Lincoln. "Recent Development in Cupola Practice," Mr. L. W. Bolton. 7 p.m.

Inst. of Heating and Ventilating Engineers.—Manchester. Associate members and graduates' visit to British Heating Industries' Works, Bolton.

MONDAY, OCT. 21ST.

Bradford Engineering Soc.—Technical College, Bradford, "Sound Waves and Musical Tones," Mr. L. Southerns. 7.30 p.m.

Inst. of Structural Engineers: Midland Counties Branch.—James Watt Memorial Inst., Birmingham. Chairman's address, Mr. G. W. Costain. 6.30 p.m.

Royal Aeronautical Soc.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. "Piloting Commercial Aircraft," Major H. G. Brackley. 6 p.m.

Wolverhampton and District Engineering Soc.—Victoria Hotel, Wolverhampton. "Measuring and Product," Mr. T. D. Curson. 7.30 p.m.

TUESDAY, OCT. 22ND.

Inst. of Automobile Engineers.—At George Hotel, Luton. Presidential address, Mr. A. J. Hancock. 7.30 p.m.

Inst. of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow, C.2. "Radio in Relation to Shipping," Mr. A. J. Gill. 7.30 p.m.

WEDNESDAY, OCT. 23RD.

Inst. of Production Engineers: Leicester and District Section.—At College of Technology, The Newarke, Leicester. "Manufacture of Optical Glass and Optical Instruments," Mr. F. Loewen. 7.30 p.m.

Inst. of Welding: N. Western Branch.—At Manchester School of Technology, Manchester. "Development of Electrical Welding Equipment," Dr. J. H. Paterson. 7.30 p.m.

N. East Coast Inst. of Engineers and Shipbuilders: Graduate Section.—Bolbec Hall, Newcastle-upon-Tyne, 1. Chairman's address, Mr. N. H. Denholm. 7.15 p.m.

Soc. of Chemical Industry: Road and Building Materials Group.—At Chemical Soc., Burlington House, W.1. Discussion, "Investigations of the Slipperiness of Roads," Dr. R. N. V. Saal. 8 p.m.

THURSDAY, OCT. 24TH.

Inst. of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C.2. Presidential address, Mr. J. M. Kennedy. 5.30 for 6 p.m.

Inst. of Metals.—James Watt Memorial Inst., Birmingham. "The Production and Control of Bronze Castings," Mr. F. W. Rowe. 7 p.m.

N. East Coast Inst. of Engineers and Shipbuilders: Teesside Branch.—At Cleveland Scientific and Technical Inst., Middlesbrough. Chairman's address, Mr. P. A. R. Leith. Cinematograph film by Mr. C. F. Christensen. 7.30 p.m.

FRIDAY, OCT. 25TH.

Coventry Engineering Soc.—The Old Technical College, Earl-street, Coventry. "Recent Developments in Physics, with Particular Regard to Recent Work on Atomic Transmutations, Cosmic Rays, Positive Electrons," Dr. V. D. Cockcroft. 7.30 p.m.

Inst. of British Foundrymen: Lancs. Branch, Junior Section.—In College of Technology, Sackville-street, Manchester. Presidential address, Mr. W. Holland. Presentation of Medals. "Question Time." 7.30 p.m.

Inst. of Chemical Engineers.—At Inst. of Civil Engineers, Gt. George-street, Westminster, S.W.1. Second Hinchley Memorial Lecture, "Our National Coal Resources," Brig.-General Sir Harold Hartley, F.R.S. 6.30 p.m.

Inst. of Heating and Ventilating Engineers: London and District Branch, Associates and Graduates.—Borough Polytechnic, S.E.1. Discussion, "Installation Problems." 7 p.m.

Manchester Assoc. of Engineers.—Engineers' Club, Manchester. "The Financial and Commercial Side of Engineering: A Review of Progress," Mr. F. C. Lawrence. 7.15 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, St. James's Park, S.W.1. Presidential address, Colonel A. E. Davidson. 6 p.m.

Inst. of Sanitary Engineers.—Caxton Hall, Westminster, S.W.1. "Ventilation," Mr. C. B. Jackson. 6 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. Informal meeting. "Luminous Discharge Tubes," Mr. C. C. Paterson. 7.30 p.m.

Keighley Assoc. of Engineers.—Queen's Hotel, Keighley. Ladies' night. Lecture by Mr. F. T. Bancroft. 7.30 p.m.

Soc. of Chemical Industry.—At Liverpool University. "The Alkali Act and its Relation to the Chemical Industry," Mr. W. A. Danion. 6 p.m.

SATURDAY, OCT. 26TH.

Inst. of Electrical Engineers: N. Eastern Centre.—Visit to Dunston 50-cycle Power Station of North-Eastern Electric Supply Company, Ltd. Leave Carliol House, Newcastle-upon-Tyne, 1.45 p.m.

Inst. of Heating and Ventilating Engineers: London Associate Members and Graduates. Visit to Vauxhall Motors, Ltd., Luton.

MONDAY, OCT. 28TH.

Inst. of Automobile Engineers.—At James Watt Memorial Inst., Birmingham. Presidential address, Mr. A. J. Hancock. 8 p.m.

Inst. of Mechanical Engineers: Graduates' Section.—Storey's-gate, St. James's Park, S.W.1. "Heat Transmission and Fluid Friction," Mr. W. H. Darlington. 6.15 for 6.45 p.m.

TUESDAY, OCT. 29TH.

Hull Chemical and Engineering Soc.—At Municipal Technical College, Park-street, Hull. Film and lecture, "The Beetle Film," Mr. N. Bond. 7.45 p.m.

Inst. of Electrical Engineers: N. Midland Centre.—At Hotel Metropole, Leeds, 1. "The Droitwich Broadcasting Station," Sir Noel Ashbridge, Messrs. H. Bishop, and B. N. MacLarty. 7 p.m.

Inst. of Electrical Engineers: S. Midland Students' Section.—James Watt Memorial Inst., Gt. Charles-street, Birmingham. "Valve Oscillators," Mr. H. D. Bickley. 6.15 for 7 p.m.

THURSDAY, OCT. 31ST.

Inst. of Automobile Engineers.—At Engineers' Club, Albert-square, Manchester. Presidential address, Mr. A. J. Hancock. 8 p.m.

Inst. of Civil Engineers: Birmingham and District Assoc.—At James Watt Memorial Inst., Birmingham, 3. Chairman's address, Mr. Cecil H. Bailey. 5.30 for 6 p.m.

FRIDAY, NOV. 1ST.

Inst. of Mechanical Engineers.—Storey's-gate, St. James's Park, S.W.1. Extra general meeting. "Strength of Metals, Under Combined Alternating Stresses," Dr. H. J. Gough and Prof. H. V. Pollard. 6 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. Informal meeting. Lecture, "Metal Spraying." Major H. J. Williams. 7.30 p.m.

MONDAY, NOV. 4TH.

Engineers' German Circle.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Die Entwicklung der Neuzeitlichen Fahrzeug-Dieselmaschine in Deutschland," Dr.-Ing. L. Hausfelder. 5.30 for 6 p.m.

Soc. of Chemical Industry: Food Group.—Burlington House, Piccadilly, W.1. Jubilee Memorial Lecture by Prof. T. M. Heilbron, F.R.S. 8 p.m.

Wolverhampton and District Engineering Soc.—Victoria Hotel, Wolverhampton. "Mechanical Equipment of Modern Coke Ovens," Mr. H. C. Wood. 7.30 p.m.

WEDNESDAY, NOV. 6TH.

Inst. of Heating and Ventilating Engineers.—At London School of Hygiene and Tropical Medicine, Keppel-street, Gower-street, W.C.1. "Electric Thermal Storage," Mr. John Eden. 7 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. Presentation of medals. Address, "International Boundaries," Col. Sir Henry McMahon. 8.30 p.m.

THURSDAY, NOV. 7TH.

Inst. of Mining and Metallurgy.—Cinema Hall, South Africa House, Trafalgar-square, W.C.2. By invitation of the High Commissioner for Union of South Africa. Film, "The Golden Harvest of the Witwatersrand." 5.15 p.m.

THURSDAY TO SATURDAY, NOV. 7TH TO 16TH.

Commercial Motor Transport Exhibition.—Olympia, Kensington, W. Open daily.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

The British Thomson-Houston Company, Ltd., has secured an order from the Borough of Leyton for the supply and erection of 267 "Diron" lanterns, control boxes, and "Mercra" lamps, and an order from the Corporation of London for twenty-three "Circra" lanterns, control gear, standards, and "Mercra" lamps for the Metropolitan Cattle Market.

Davey, Paxman and Co. (Colchester), Ltd., have received an order for an eight-cylinder heavy duty oil engine, capable of developing 440 b.h.p. at 650 r.p.m., for the main propulsion of an oil-electric tug which Smith's Dock Company, Ltd., is to construct for the Erith and Dartford Lighterage Company, Ltd., to the specification and under the supervision of Burls, Gordon and Whiteford, London. The engine will be direct coupled to G.E.C. electrical propulsion equipment. The propulsion motor will run at 120 r.p.m. at full speed when towing. The auxiliary equipment will include a Paxman-Ricardo 10–11 b.h.p. high-speed oil engine at 1000 r.p.m., driving a 5-kW dynamo, air compressor, and bilge pump. The company has also received an order from the Army and Navy Co-operative Society, Ltd., for a "Vee" type Paxman-Ricardo high-speed oil engine. The engine is similar to the one exhibited by the firm at the recent Shipping, Engineering and Machinery Exhibition, and is of twelve cylinders, capable of developing 350 b.h.p. at 1000 r.p.m. It will be direct coupled to a 230-kW Crompton-Parkinson D.C. generator.